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WE GUARANTEE, that of this issue 10,900 copies were printed; that of those 10,900 copies, 9,759 copies were mailed or delivered by messenger to regular paid subscribers; 845 copies were distributed among members and guests of the American Railway Engineering Association and at the Coliseum; 146 copies were mailed to advertisers; and 150 copies were set aside for office use.

Contents

Changing the Fiscal Year

The suggestion made by Chairman Jenkins of the Track Committee yesterday morning that the subject of a change in the ending of the fiscal year be assigned to this committee for study will undoubtedly meet with the ready approval of every operating and engineering officer, and President Wendt's promptness in seconding this suggestion is to be commended. More than any other single factor, the present termination of the fiscal year in the middle of the natural season for track work tends unnecessarily to increase the cost of maintenance work on most railways. Over 55 per cent of the total expenditures for maintenance of way and structures are for labor. The present wide fluctuations in forces and the tendency to reduce the amount of work to a minimum during the spring months and to increase it as traffic grows heavier, are disastrous to economy and are costing the railways of the country millions of dollars annually. It may be conservatively stated that if the work could be organized and carried out with absolute disregard of the present fiscal year a saving of 20 per cent in labor could be made. Taking all the railroads of the country this would be equivalent to over $30,000,000 annually. The only practical remedy for the situation is to change the fiscal year so that it will coincide with the calendar year—in other words, so that if track work is to be interrupted for financial reasons this will be done when it will cause a minimum of harm. No greater opportunity for constructive work can be found than in carrying out the suggestion made by Chairman Jenkins; and it is believed that railway men generally are in accord with it. It is to be hoped that the board will act favorably on it.

Registration and Attendance

The registration of members up to the evening of the second day was 475 this year, as compared with 407 up to the corresponding time last year. This increase of more than 10 per cent in the attendance is also shown by the large numbers that have been present at all of the sessions of the convention thus far. The Florentine room seats 350, and during a large part of the time practically every chair in the room has been occupied, and groups of men have filled the corridors adjacent to the meeting room. It is also noteworthy that each year brings an increasingly large number of higher operating and executive officers as well as the members of the engineering department.

William Benson Storey, Jr.

William Benson Storey, Jr., who was elected president of the American Railway Engineering Association yesterday, is vice-president in charge of construction and operation of the Atchison, Topeka & Santa Fe System, with office at Chicago, Ill. Mr. Storey was born November 17, 1857, at San Francisco, Cal., and was educated at the University of California, graduating with the class of 1881. He had previously entered railway service in 1887 as an axman on the Southern Pacific, and after serving one year in this position he entered college. After his graduation, in 1881, he re-entered railway service with the Southern Pacific, and was consecutively until 1893 rodman, levelman, transitman and assistant engineer. From 1893 to 1895 he was out of the railway service as assistant engineer with the United States Hydraulic Mining Commission. Returning to railway work in 1895, he was for five years, until 1900, chief engineer and general superintendent of the San Francisco & San Joaquin Valley, now a part of the Coast Lines of the Santa Fe system. In 1900 he was appointed chief engineer of the Atchison, Topeka & Santa Fe Railway, with headquarters at Topeka, Kan., and retained that position for six years. From 1906 to 1909 he was chief engineer of the entire system. In 1909 he was elected vice-president of the system, in charge of construction, with office at Chicago. In 1910, when Vice-President J. W. Kendrick retired, he was given jurisdiction also over the operating department, and has the distinction of having a greater mileage of line under his charge than any other vice-president in the country, 10,771 miles being comprised in the Santa Fe system. The association is thus unusually fortunate in having at its head not only a high executive officer, but one who, having gained most of his experience in the engineering department, now combines in his authority both the engineering and operating departments of his road. Mr. Storey has been first vice-president of the association during the past year, and during the previous year was second vice-president, and the association is to be congratulated upon having for its president a man of such great prominence and attainments in his profession.

Operating Men in the Association

For the first time in its history, the American Railway Engineering Association has an operating officer as its president, who in this instance is also an executive officer. This serves to emphasize the closer relationship between the engineering and operating departments which is becoming increasingly manifest in the work of the association. This is evident in the reports of several of the committees. In the report on Yards and Terminals one of the topics discussed is methods of operation and cost of hump yards, which is a joint engineering and operating question, as are the discussions on speeds of trains on curves and turnouts in the Track report, on savings possible from water-softening in the Water Service report, and on standard trespass and crossing signs in the report of the Committee on Signs, Fences and Crossings. Formerly members of the association transferred or promoted into the operating department gave up their membership or relaxed their interest in association affairs. That this is no longer true is indicated by the number of committee chairmen who are now operating officers, including L. A. Downs, of the Committee on Ties, who is a division superintendent of the Illinois Central; C. H. Stein, of the Committee on Signs, Fences and Crossings, who has recently been promoted from engineer maintenance of way to division superintendent of the Central of New Jersey; G. D. Brooke, of the Rules and Organization Committee, division superintendent of the Baltimore & Ohio, and R. N. Begien, of the Committee on Economics of Railway Location, general superintendent of the Baltimore & Ohio. It is exceedingly fortunate for the association that these men do retain their active interest in its work, and that the organization is thus able to maintain such a close relation to the operating department. Moreover, the association is fortunate in having as members of its board of directors two such prominent executive officers as W. B. Scott, president of the Sunset-Central Lines and F. A. Delano, president of the Monon.

SPEED ON CURVES AND TURNOUTS

The study of the speed of trains on curves and through turnouts, made by the Track committee, is an example of numerous special, but nevertheless very important, investigations made from year to year by the American Railway Engineering Association. The elevation of curves on tracks used in common by high speed passenger trains and slow tonnage freight trains has always been a difficult problem to solve satisfactorily. It is, of course, essential that the curves be elevated sufficiently to give safe and easy riding track for the fastest passenger train, while any greater elevation unnecessarily increases the resistance of freight trains and tends to limit their tonnage. The principles of curve elevation are generally understood and the problem is one of their proper application. The speed of trains through turnouts, however, presents an essentially different problem, and the principles are not so well understood. The absence of any elevation through the lead and the angle at the switchpoint introduce elements of danger. The series of accidents on the New Haven about two years ago have focused attention on this question. At that time the absence of accurate knowledge regarding safe speeds through turnouts of various lengths gave rise to many misleading statements by men in positions of authority, which tended to cloud the entire subject. The intimation that No. 20 turnouts were safe for trains at all speeds, sent out by the Public Utilities Commission of Connecticut in justifying its order requiring the New Haven to replace all short turnouts with those of this length, was a case in point. In times of agitation and controversy it is well to get down to the basic underlying principles, as has been done in this study. If the information published in this report had been available at the time of the New Haven accident, it would have been of great assistance to railway men and regulating authorities alike. This study is important not only for reference purposes but for daily use as well, for the engineer must assume responsibility for the construction of track which will be safe for trains operating at the maximum allowable speed or for the limitation of the speed within the safe limits of track construction.

NEW OFFICERS OF THE A. R. E. A.

The election of officers of the American Railway Engineering Association for the coming year which was announced by President Wendt just before the close of the afternoon session yesterday resulted as follows:

President, W. B. Storey, vice-president Atchison, Topeka & Santa Fe System, Chicago; first vice-president, Robert Trimble, chief engineer maintenance of way, northwest system, Pennsylvania Lines West, Pittsburgh, Pa.; second vice-president, A. S. Baldwin, chief engineer, Illinois Central, Chicago; treasurer, G. H. Bremner, assistant district engineer, division of valuation, Interstate Commerce Commission, Chicago; secretary, E. H. Fritch, Chicago; directors for three years, Earl Stimson, engineer maintenance of way, Baltimore & Ohio, Baltimore, Md., Curtis Dougherty, chief engineer, Cincinnati, New Orleans & Texas Pacific, Cincinnati, O., and G. J. Ray, chief engineer, Delaware, Lackawanna & Western, Hoboken, N. J., members of the nominating committee, C. F. Allen, professor of railroad engineering, Massachusetts Institute of Technology, Boston, Mass., J. V. Hanna, chief engineer, Kansas City Terminal, Kansas City, Mo., Maurice Coburn, principal assistant engineer, Vandalia, St. Louis, Mo., J. B. Jenkins, valuation engineer, Baltimore & Ohio, Baltimore, Md., and C. C. Anthony, assistant signal engineer, Pennsylvania Railroad, Philadelphia, Pa.

RECORD CONSTRUCTION ON THE MILWAUKEE

A little over 66,000 cu. yd. of material has been handled every day, on the average, for the last two years on the Chicago, Milwaukee & St. Paul system, and during the same time 772 yd. of concrete has been placed on the average every day. These average figures were, of course, exceeded very greatly at times, the average for the heaviest month of 1912 being 121,266 yd. of grading per day. During 1912 the total earthwork handled, including earth, loose rock, rock, ballast and gravel, amounted to 23,750,200 cu. yd. The similar figure for 1913 was 24,553,411, making a total for the two years of 48,303,611 yd. The total amount of concrete placed in 1912 was 246,823 yd. and in 1913, 316,989 yd.

This concrete work involved the use of 446,079 barrels of cement and 15,682 lb. of reinforcing steel. The bridge work handled during these two years involved the erection of 37,601 tons of steel, including the Des Moines river viaduct which contained 6,381 tons. A total of 741 structures were built, including 66 steel bridges, 230 arch bar top culverts, 39 concrete and steel trestles, 95 highway overcrossings and 311 miscellaneous foundations, roundhouse pits, turntables, etc. More than three miles of concrete slabs for deck girder structures were placed, over six miles of concrete pipe laid, nearly six miles of concrete piles driven, and over one mile of tunnel lines on the system during these two years.

The 1913 record was made in the construction of new line in Washington and Oregon and about 150 miles of second track on the main line in Iowa and 40 miles of second track between Minneapolis and Montevideo.

THE REYNOLDS LOVING CUP

The accompanying illustration shows the loving cup which was presented to John N. Reynolds at the annual meeting of the National Railway Appliances Association on Tuesday, in appreciation of his twelve years of active continuous service as an officer of that association, as secretary and treasurer until the increase in the duties of those offices made necessary a division of the work and as treasurer since that time. The full account of the meeting at which this token was presented was published in the Daily issue yesterday morning. Mr. Reynolds has been connected with

Loving Cup Presented to John N. Reynolds.

publications in the railway field continuously since 1872, and during this 42 years of active work has formed a very wide circle of acquaintances among both railway men and representatives of railway supply companies.

ANNUAL LUNCHEON OF BALTIMORE & OHIO MEN

The annual luncheon of the Baltimore & Ohio men attending the convention of the American Railway Engineering Association was held at the Congress hotel yesterday. It was attended by over 80 officers of the Baltimore & Ohio System, including the Cincinnati, Hamilton & Dayton. Francis Lee Stuart was toastmaster, and addresses were made by A. W. Thompson, third vice-president; C. W. Galloway, general manager of the eastern lines; J. M. Davis, general manager of the western lines; Earl Stimson, engineer maintenance of way, and F. P. Patenall, signal engineer. Mr. Thompson, in his remarks, gave high praise to the work of the engineering and maintenance of way departments of the road, and especially urged upon the maintenance officers the necessity, in view of existing conditions, of exercising the greatest practicable economy while at the same time maintaining the property in good and safe condition. He also urged the desirability of engineering and maintenance officers attending the meetings of the American Railway Engineering Association and participating in its committee work and discussions.

Those attending the luncheon were the following:

E. H. Fritch, Secretary, American Railway Engineering Association; F. C. Batchelder, Assistant to President; A. W. Thompson, Third Vice-President; C. W. Galloway, General Manager; J. M. Davis, General Manager; F. L. Stuart, Chief Engineer; F. H. Clark, General Supt. Motive Power; G. H. Campbell, Assistant to President; E. Stimson, Engineer M. of W.; F. P. Patenall, Signal Engineer; R. N. Begien, General Superintendent; M. A. Long, Asst. to Chief Engineer; J. T. Carroll, Asst. Genl. Supt. Motive Power; G. A. Schmoll, District Supt. M. P.; J. B. Carothers, Asst. to General Manager; G. W. Andrews, Inspr. Maintenance; M. K. Barnum, Genl. Inspr. Machinery & Equipment; F. J. Angier, Supt. Timber Preservation; G. D. Brooke, Superintendent; L. G. Curtis, District Engineer; E. E. Hamilton, Supervisor Operating Statistics; H. M. Church, District Engineer M. of W.; S. A. Jordan, District Engineer M. of W.; F. D. Batchellor, District Engineer M. of W.; J. A. Spielmann, District Engineer M. of W.; G. H. Dryden, Asst. Signal Engineer; E. R. Sparks, Secy. to Chief Engineer; J. H. Adamson, Field Engineer; J. T. Andrews, Asst. Engineer; J. O. Potts, Maintenance Inspr.; H. R. Bricker, Inspector; Z. T. Brantner, Superintendent Shops; H. L. Marshall, General Ballast Inspr.; F. F. Hanly, Asst. Engineer; P. A. Witherspoon, Asst. Engineer; J. B. Jenkins, Valuation Engineer; C. E. Newhouse, Field Engineer; W. B. Redgrave, Engineer M. of W.; W. C. Coles, Field Engineer; E. T. Brown, Div. Eng.; J. B. Cameron, Div. Eng; H. A. Cassil, Div. Eng.; G. F. Eberly, Div. Eng.; L. E. Haislip, Div. Eng.; H. H. Harsh, Div. Eng.; H. M Hayward, Div. Eng.; C. H. R. Howe, Div. Eng.; E. D. Jackson, Div. Eng.; J. B. Myers, Div. Eng.; G. P. Palmer, Div. Eng.; H. S. Passell, Div. Eng.; P. Petri, Div. Eng.; E. V. Smith, Div. Eng.; John Tordella, Div. Eng.; W. I. Trench, Div. Eng.; W. F. Strouse, Assistant Engineer; J. E. Teal, Assistant Engineer; M. F. Steinberger, Assistant Engineer; E. H. Barnhart, Asst. Division Engineer; V. P. Drugan, Asst. Division Engineer; Richard Brooke, Asst. Division Engineer; O. C. Spieth, Asst. Division Engineer; A. P. Williams, Asst. Division Engineer; J. E. Lloyd, Asst. Division Engineer; W. C. Bowlin, Assistant Engineer; H. L. Gordon, Assistant Engineer; A. H. Griffith, Assistant Engineer; F. G. Hoskins, Asst. Division Engineer; W. T. Hughes, Asst. Division Engineer; F. E. Lamphere, Assistant Engineer; W. G. Moore, Assistant Engineer; A. H. Woerner, Asst. Division Engineer; Samuel O. Dunn, Editor, Railway Age Gazette.

TO-DAY'S PROGRAMME

III.	Ties	Bulletin 164
IX.	Signs, Fences and Crossings	Bulletin 164
XIX.	Conservation of Natural Resources	Bulletin 164
XVI.	Economics of Railway Location	Bulletin 164
Special.	Uniform General Contract Forms	Bulletin 164
XI.	Records and Accounts	Bulletin 164
II.	Ballast	Bulletin 164
	New Business.	
	Installation of Officers.	
	Adjournment.	

NEW YORK CENTRAL BRIDGE COMMITTEE

The bridge committee of the New York Central Lines reserved a table at the banquet last night and all the members present were seated together. The committee consists of one or more representatives from each road in the New York Central system and meets regularly once a month to consider specifications and general topics of interest to the bridge department.

JOINT COMMITTEE ON MANGANESE CONSTRUCTION

At a meeting of the Track Committee on Tuesday afternoon a sub-committee was appointed to confer with a committee representing the manufacturers of manganese crossings frogs and switches to standardize the design and construction of manganese work for the purpose of improving the product.

NEW POSITION FOR E. W. RICHEY

E. W. Richey, formerly secretary and general sales agent of the Standard Forgings Company, has become associated with A. M. Castle & Co., Chicago, Ill.

Proceedings of American Railway Engineering Association

Abstracts of Reports on Masonry, Track, Electricity, Wood Preservation, Grading of Lumber, Water Service, Buildings and Rail

The Wednesday morning session of the American Railway Engineering Association was called to order at 9:30 a. m., by President Wendt, the first order of business being the completion of the discussion on Iron and Steel Structures which was begun Tuesday afternoon. The following committees reported at the two sessions: Masonry, Track, Electricity, Wood Preservation, Grading of Lumber, Water Service, Buildings and Rail. Abstracts of these reports, with the discussion that followed the presentation of each, are given below. The afternoon session closed with the report of the tellers on the election of officers for the coming year, the result of which is shown in another column.

IRON AND STEEL STRUCTURES

Discussion on Iron and Steel Structures (Continued).

A. J. Himes, Chairman: The subject covered in Appendix D has been carefully studied by a joint sub-committee representing Committees II and III of the Railway Signal Association and Committees X and XV of the A. R. E. A., and the report, as presented in Appendix D, is recommended for adoption.

W. H. Moore: Some members of the committee feel that paragraph C as printed cuts out altogether the detail very often used in connection with a mitred rail. We feel that this mitred rail is very desirable in some cases, especially in lift bridges on account of the smooth riding and absence of hammering which it produces.

A. H. Rudd (Penn.): If mitred rails are good for lift bridges, I do not understand why they are not good for swing bridges. The Pennsylvania uses mitred rails on its high speed swing bridges successfully; the Lackawanna in some places, and quite a number of the other Eastern roads. I see now that the committee recognizes that mitred rails might be used, and I would be glad if they would permit their use on swing bridges as well as lift bridges. I propose to offer as an amendment to paragraph C eliminating the words "cut square and," and eliminating the last clause, so it will read "or by easer rails to carry the wheels over the opening between the end of bridge and approach rails," and stop there. That will permit the use of either mitre or square cut rail and recognize both as good practice without going into the specifications very deeply.

C. H. Stein (C. of N. J.): I agree with what Mr. Rudd has said in regard to the use of mitred rails. Our line has been using the mitre ends for all of its swing bridges, as well as all of its lift bridges. A certain connecting line over which our road runs adopted a type of square joint similar to that recommended by the committee, and after it had been in use for perhaps a year it had given them no end of trouble and annoyance, and they were replaced by mitred ends.

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W. B. STOREY, JR., President-Elect.

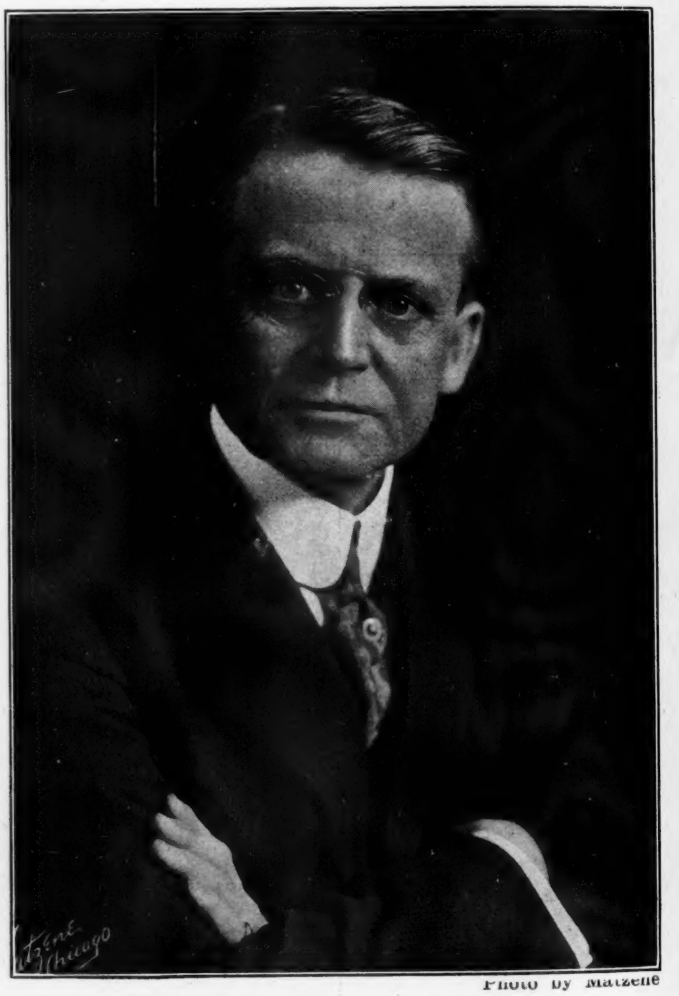


Photo by Matzene

A. S. BALDWIN, Second Vice-President-Elect.

Mr. Himes: The majority of the committees are opposed to mitred rails on either swing or lift bridges. We are opposed to them, especially swing bridges, because with mitred rails we cannot swing the bridge without lifting the rails. The lifting of the rails means that a certain length must be loose, held in position for traffic by chains. The committee purposely and intentionally raised the issue and recommended that for safety of draw bridge operation that these loose rails at the end of a draw bridge be done away with.

E. A. Frink (S. A. L.): The Seaboard has quite a number of draw bridges that have been equipped with mitred rails

for a number of years. So far we have had very little, if any, trouble over them. The mitred rail, in connection with the lift bridge, gives you an excellent chance to provide your interlocking or signal mechanism with deck lock as well as rail lock, so it prevents signals until the rails are down and locked in place. In the mitred rails that we use the ends of the rails are at a right angle before the rails are mitred. In that way we get very good wearing qualities, a very durable rail.

Mr. Rudd: My amendment is that "rail ends should be connected by solid sleeve or joint bars, or by easer rails, to carry the rails over the opening between the end of the bridge and the bridge rails." I might say that without locking device, the signal cannot be given if the rail is up more than a quarter of an inch.

Mr. Stein: I second the amendment. I simply want the committee to permit the railroads a certain amount of latitude in that matter, so that they may adopt their own preferences. In our experience covering fifteen or twenty years with the mitred rail we have never experienced any trouble on account of this rail being loose. I do not contend that the mitred rails never come down and block on top of the rigid rail. On our line the clearance is adjusted to ⅛ in. I do not know of any that have given any trouble or broken under traffic, and the speed is confined to forty miles an hour over the draw bridge.

G. J. Ray (D. L. & W.): We have some draw bridges in our territory where we have more than one hundred suburban trains passing over them each day. I am sure that we have never experienced any undue difficulty, which shows that the performance of the mitred rails is satisfactory.

A. W. Carpenter (N. Y. C. & H. R.): My experience with the lift rails has not been in accord with that of the other speakers. I know of a case of a bridge equipped with the most modern form of lift rail for swing bridges, fully interlocked, locks being provided for the ends of every rail, and yet there was an accident on that bridge. It was apparent that the lift rails failed to work. Therefore, I have come strongly of the opinion that for high speed operation the square end joint is better. However, it does not ride as well as the mitred rail.

B. R. Leffler (L. S. & M. S.): The present practice on the Lake Shore is to have square ends. The loose rail, I do not believe, can be thoroughly interlocked so as to take care of the broken rail condition. As far as the smooth riding of the track is concerned, with the square end rail there is a slight roughness due to the false flanges on the wheels, but there is no more roughness than is found in the crossings or in switch frogs. I have seen mitred rails that were hammered pretty badly. The experience that we have had is that under heavy axle loads as we are having to-day the mitred rail will not hold up under traffic conditions. I think most engineers have a feeling that a mitred rail is something like a facing point switch when the traffic is against it.

H. R. Safford (G. T.): My personal experience leads me to believe that the square end joint is a much stronger form of track rail. There is a type of mitre rail, which is in effect that dove tail joint, but the rail is specially made so that the full supporting power of the web is maintained practically all the way through. However, if by mitered joint is meant a rail planed off at an angle, I am opposed to it.

Mr. Stein: On one particular bridge which we have over Newark Bay, we have from 250 to 300 movements in each direction each day, there are something nearly 600 trains which pass over this bridge each day. At least 200 of these movements are at high speed running around 40 miles an hour, and sometimes in excess of that. With all of our experience with the mitre rails we have had no difficulty to speak of, and only occasionally would they fail to drop properly into their proper positions. They may bind, perhaps, a little on the eye, or something of that sort, but with just a little touch of a hammer or bar will set them in proper position.

W. H. Elliott (N. Y. C. & H. R.): As a representative of the sub-committee of Committee X, which made this report, I would say from a signaling standpoint it is our opinion that either arrangement of rail ends might be interlocked with equal security, so that discussion of the subject from the signaling standpoint is one that has to do with the supporting or carrying of the wheel across the gap, rather than a signal matter.

Mr. Himes: A very large number of the sliding joints are in successful operation and have been for years. It is true that you cannot operate the sliding sleeve unless the rails are properly centered, and in order to secure that we have a step at the end of the bridge, a jacking device, which centers the bridge absolutely, so that there is no difficulty whatever about the operation of this device. The work of the committee has been carried on in full view of the vital situation which has developed in recent years pertaining to the safety of railroad traffic, and in particular the safety of traffic over draw bridges. The strongest merit of the sliding joint is that it permits the rail to be spiked right up to the end of the bridge.

Mr. Rudd: The draw bridge is a place where you can spend money to better advantage perhaps than anywhere else. It is not a question of economy. It is a question of the effectiveness. On our single track lines we use the square end rail, but on double and four-track lines we use the mitre rail, because we get better results and can run at high speed, in our opinion, with less danger.

The President: The question is on the amendment proposed by Mr. Rudd. Please read the paragraph as it will be under your amendment.

Mr. Rudd: "Rail ends should be connected by sliding sleeve or joint bars or by easer rails to carry the wheels over the opening between the end of the bridge and the approach to the bridge"; that is, we eliminate the words "cut square and" and eliminate the last clause.

(This paragraph was then adopted as amended.)

Mr. J. E. Crawford (N. & W.): I move that Appendix D be withdrawn from consideration this year and be postponed until next year. I feel, in the first place, that there have been some amendments offered that have not been fully considered, and that these recommendations as worded are too positive. They should be more in the nature of recommended practice than of a specification.

(The motion was carried.)

Mr. Lindsay: I feel that the subject, "Bridge Clearance Diagram," is intimately related to the subject of clearances pending before the Committee on Electricity, and I move that the subject be referred to the committees on Iron and Steel Structures and on Electricity for joint consideration and action.

(The motion was carried.)

(The two clauses offered as an amendment to the instructions as now published in the 1914 Proceedings, on page 88, were adopted.)

Mr. Himes: The recommendation of the committee is that we continue the study of built-up columns, the design and length of turn tables, and the study of secondary stresses and impact; also to take up the consideration of live load and the column formula.

MASONRY

The subject of Waterproofing of Masonry has been under investigation by the committee for the past five years. During this time a large amount of information has been collected and analyzed. Progress reports have been made at the eleventh, twelfth and thirteenth annual conventions, and a final report is presented at this time.

The subject of "Effect on Concrete Structures of Rusting of the Reinforcing Material" has been considered under the more general subject of "Disintegration of Concrete," a report upon which is herewith presented.

The joint committee on Concrete and Reinforced Concrete held no meeting during 1913. Its report, adopted by the American Society of Civil Engineers in January, by the American Railway Engineering Association in March and by the American Society for Testing Materials in June, was given publicity and criticism invited. The committee will endeavor, in 1914, to round out its report to represent the best American practice.

In October, 1912, a sub-committee of a Committee C-1 of the American Society for Testing Materials on Standard Specifications for Cement, was appointed to co-operate with a sub-committee of the departmental committee of the Government in an effort to harmonize the differences existing between the specifications adopted by the former committee and the specifications written by the departmental committee, and by executive order put into effect as a standard specification for cement for all departments of the Government. As the methods of tests on which Committee C-1 based its specifications were prepared by a committee of the American Society of Civil Engineers, which has been dismissed, that society was asked to appoint a special committee to co-operate with the sub-committee of the departmental committee and the sub-committee of committee C1. These committees are organized as a joint conference on uniform methods of tests and standard specifications for cement. By unanimous vote, the chairman of committee C-1 was authorized to appoint this sub-committee of three, and though neither of our representatives was appointed, they

approved of the action taken. A number of meetings of the joint conference have been held, and several tests and investigations conducted. Considerable progress has been made in reconciling differences, and it is expected that the conference will be in position to make a report during the current year.

NEXT YEAR'S WORK.

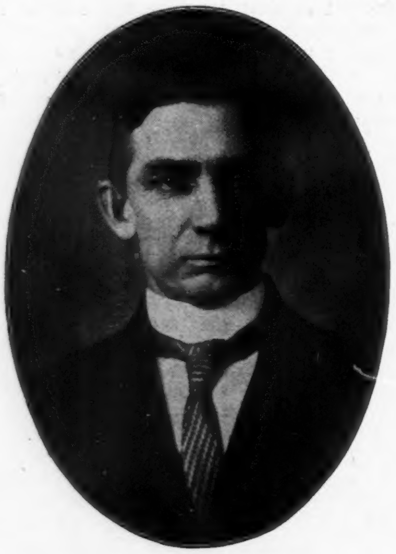
It is recommended that the subject of "Principles of Design of Plain and Reinforced Retaining Walls, Abutments and Trestles" be continued and a further effort be made to obtain some data upon the pressure of earth upon retaining walls. It is also recommended that the Specifications for Plain and Reinforced Concrete Masonry be revised.

CONCLUSIONS.

(1) It is recommended that the conclusions under "Waterproofing of Masonry and Bridge Floors" be adopted and published in the Manual.

(2) It is recommended that the conclusions under "Disintegration of Concrete" be adopted and published in the Manual.

G. H. Tinker (N. Y. C. & St. L.), chairman; F. L. Thompson (I. C.), vice-chairman; R. Armour (G. T.), J. C. Beye (C. R. I. & P.), C. W. Boynton (Universal Portland Cement Co.), W. A. Clark (D. & I. R.), T. L. Condron (Consulting Engr.), J. K. Conner (L. E. & W.), G. W. Hegel (C. S.), L. J. Hotchkiss, Richard L. Humphrey (Consulting Engr.), J. H. Prior (C. M. & St. P.), F. E. Schall (L V), G. H. Scribner, Jr. (Contracting Engr.), A. N. Talbot (Univ. of Illinois), Frank Taylor (C. P.), Job Tuthill (K. C. T.), J. J. Yates (C. R. R. of N. J.), Committee.



G. H. TINKER,
Chairman Committee on Masonry.

APPENDIX A.

Waterproofing Masonry and Bridge Floors.

Masonry construction should usually be impervious to water in order that it may be protected from possible disintegration. The presence of water within masonry structures not designed to retain water is objectionable.

Structures should be waterproof when it is necessary to prevent dampness in walls above grade, and in walls and floors below grade; to prevent flooding basements and pits which are at all times or occasionally below the ground water level; to prevent percolation or leakage of water through the masonry and the formation of unsightly deposits on exposed surfaces; to prevent the dripping of water through a bridge floor over a street, and in the cases of solid floors of steel or reinforced concrete bridges, to protect the steel from corrosion; to prevent the entrance of water into tunnels, either above or below ground water level, or subaqueous tunnels; to prevent leakage from reservoirs; and to prevent the penetration of water into masonry.

The outline given below includes the ordinary methods of waterproofing:

(I) COATINGS.
- (1) Linseed oil paints and varnishes.
- (2) Bituminous:
  - Asphalt.
  - Coal Tar.
- (3) Liquid hydrocarbons.
- (4) Miscellaneous compounds.
- (5) Cement mortar.

(II) MEMBRANES.
- Felts and burlaps in combination with various cementing compounds.

(III) INTEGRALS.
- (1) Inert fillers.
- (2) Active fillers.

(IV) WATERTIGHT CONCRETE CONSTRUCTION.

Walls above grade are waterproofed by coating with paints, varnishes, or waterproofing washes, or by plastering with cement mortar. The coating or plaster may be applied either on the inside or outside of the wall. The walls of basements and pits are waterproofed, either by the application of coatings, membranes, integral or watertight concrete construction. Membranes are usually protected with concrete, brick or bituminous binder. Where basement or pit walls and floors are below the ground water level, they must be so designed as to resist the existing hydrostatic head in order to prevent cracks and leakage. Such walls may be waterproofed by the integral method or by watertight concrete construction. When exterior waterproofing is employed, the membrane method is generally used properly protected.

Stone, brick or concrete arches, retaining walls, abutments, subway walls and culverts are waterproofed by any of the methods mentioned in the preceding paragraph. For important structures, the membrane method is most generally used. When surface coatings, integral waterproofing or watertight concrete construction is used, particular attention must be paid to reinforce the work against cracks due to expansion, contraction or settlement. The expansion joints must be waterproofed by sheet copper or lead built into the adjoining sections.

The solid floors of steel and reinforced concrete bridges probably present the most difficult problems of waterproofing. In steel trough or I-beam floors a concrete filling may be used to bring the deck up level with, or above the top of the steel in the floor. The floors of this class of structures are usually waterproofed by the membrane method.

Tunnels in which the ground water level is below the invert may be waterproofed by any of the aforementioned methods. Subaqueous tunnels present a different and distinct problem of waterproofing; usually reinforced concrete, or plain concrete, with iron or steel lining is used. The structures are designed to resist the hydrostatic head. The walls and floors of reservoirs may be waterproofed by any of the four methods before mentioned.

COATINGS.

Linseed oil paints and all coatings containing linseed oil are reactive to atmospheric conditions and to alkaline water. Applied as a damp-proofing to the surface of a concrete wall which may be permeable to moisture, the paint is likely to be of short life, unless the surface is specially prepared. To secure the best results, the wall must be dry and clean before application. The paint is applied with a brush in the ordinary manner. The coating power of paint is approximately 200 sq. ft. of wall per gallon of paint, but varies with the thickness of the paint and the nature of the surface. The prices of the paints sold for damp-proofing masonry and concrete surfaces vary from about $1 to $3 per gallon for the material.

Bituminous coatings include asphalt, petroleum residuum, coal tar and coal tar pitch. As used for waterproofing purposes, they are solid at ordinary temperatures and are, therefore, often applied while hot. As they are soluble in benzine and coal tar naphtha, they are frequently mixed with these solvents and applied in a liquid form. Two coats cost about one cent for material and one-quarter cent for labor per sq. ft.

Waterproofing by the application of liquified asphalt, as a paint applied with a brush or mop, has been used on practically all kinds of engineering structures as a surface coating. Bituminous coatings applied cold by dissolving in naphtha, instead of hot, do not set instantly, therefore are much easier to apply. The work can be done by an ordinary laborer, care rather than skill being required in handling. All walls that are to be waterproofed must first be allowed to dry. If the waterproofing is made by dissolving the bitumens in a volatile solvent with a dryer so that it may be applied cold like a paint, it is difficult, if not impossible, to prepare a paint that will dry to the right consistency and then stop. The usual result is that the drying and hardening continues

until it reaches a point where its waterproofing qualities are destroyed.

Hot asphalt will not adhere to cold, damp concrete. Several different methods of heating the surface of the concrete have been used. Gasoline has been poured over the surface and burned; hot sand has been spread over the surface and swept back as the waterproofing proceeds. It is claimed, however, that heating the surface draws up moisture and prevents the asphalt from adhering. It is necessary that the concrete be thoroughly dry before the asphalt mixture is laid upon it, as the steam caused by placing the hot material upon a damp foundation will prevent adhesion. Good results have been obtained by first painting the surface to be treated with a priming coat of asphalt cut with naphtha or benzine and then applying the hot asphalt over this coat. In applying hot asphalt directly to steel, difficulty is found in getting the asphalt to adhere to the steel, and no dependence can be placed upon adhesion to vertical surfaces.

The asphalt should be heated in a suitable kettle to a temperature not exceeding that allowed in the specifications for any particular structure, depending upon the material used. If this temperature is exceeded, it may result in pitching the asphalt. Before the pitching point is reached, the vapor from the kettle is of a bluish tinge, which changes to a yellowish tinge after the danger point is exceeded. The asphalt has been cooked sufficiently when a piece of wood can be put in and withdrawn without the asphalt clinging to it. Asphalt coatings cost about sixty-five cents per gallon for material and three-tenths cent for labor per sq. ft., a gallon covering about 100 sq. ft. per coat.

Various results have been obtained by the use of asphalt mastic, and it is probable that much is dependent upon the quality of the mastic. The requirements of a sand for asphalt mastic are much the same as those for cement mortar. It is common practice to mix a certain amount of limestone screenings with the sand, with the intention of securing an aggregate with the least percentage of voids. The strength and compactness of the mastic will depend considerably upon the percentage of voids, and the proportion of asphalt used in the mastic should be sufficient to fill the voids and completely coat each particle of sand and screenings. Too much asphalt will produce a mastic that is soft and easily indented, does not offer a good protection against the ballast on a bridge floor and flows more readily than a well-proportioned mixture.

The asphalt and sand are separately heated to from 325 to 350 degrees. The proper proportions are measured out simultaneously, poured into a mixing vessel and thoroughly mixed. The operation of mixing the asphalt mastic requires care in heating the ingredients to secure uniform temperature, not to overheat the asphalt, to proportion the mixture accurately, and to mix the materials thoroughly. The mixture is dumped in place and spread evenly over the surface with wooden floats, shovels or rakes. After being compressed with tampers, the surface is finished with hot smoothing irons.

Asphalt mastics are usually applied in layers not exceeding ⅝ in. thick. Usually two coats are applied, the coats to break joints not less than one foot. The cost of asphaltic mastic 1¼ in. thick is about $30 for material per net ton, a ton covering about 375 sq. ft.; the cost of labor is about two to five cents per square foot, depending upon location and conditions.

Tar produced by the distillation of bituminous coal is used in waterproofing, either applied cold as a paint by dissolving in naphtha or benzine or applied hot. It is also mixed with sand, gravel or screenings to form a mastic. It is generally found to be difficult to obtain coal tar of good quality. Good coal tar compares favorably with asphalt as a waterproofing material. The present price of coal tar pitch, used for waterproofing, is about $17.50 per net ton.

Coal-tar Paint.

Annapolis mixture is a coal tar paint composed of one part kerosene oil, four parts Portland cement and sixteen parts refined coal tar. The mixture is put on with a paint brush in the same way ordinary paint is applied. The compound not only covers the surface, but sinks into and bonds with it, so that two or three coats are sometimes required. It has been found to adhere to moist or even wet concrete.

The cost for three coats is about one-half cent for material and about one-half cent for labor per square foot.

Waterproofing by the application of a coating of melted paraffin has been used on masonry in much the same manner as hot asphalt. Paraffin is also applied cold as a paint made by dissolving the paraffin with naphtha. Petroleum oil is sometimes applied to the surface of masonry as waterproofing. The efficiency of these materials depends upon their absorption into the surface of the masonry. Applied to clean, dry surfaces of porous masonry, they are fairly efficient as damp-proofing.

Solutions of soap applied as a wash for waterproofing or damp-proofing masonry surfaces are not recommended, as no permanent waterproofing effect can be depended upon. Waterproofing by alternate washes of soap and alum is one of the oldest methods of treating masonry surfaces, and has given fair results when properly used on surfaces sufficiently dense and impermeable to afford support for the void-filling material. Inferior materials and workmanship cannot be atoned for by the use of alum and soap washes. The alum and soap combine and form an insoluble non-absorptive compound in the pores of the masonry surface. The cost of applying two coats each of soap and alum washes is about one-half cent per square foot of surface.

The method of waterproofing masonry structures by the application of a plaster coat has proved efficient when the plaster has been properly applied. The surface to be waterproofed must be clean to insure a bond between plaster and masonry. Old surfaces may be cleaned by chipping off a thin layer from the face or by the use of a sand blast or steam jet. The surface must then be kept wet until it has absorbed water to its full capacity. A wash of neat cement mortar should then be applied with a brush. This wash should be mixed to the consistency of cream and should never be used after it is 45 minutes old. The plaster should be applied over the cement wash before the latter has commenced to dry. The sand used in the mortar should receive careful attention. It should be well graded from fine to coarse, the maximum size or particles being that passing a No. 8 sieve. Portland cement and sand should be mixed in the proportion of 1:1½. The mortar should be applied in layers about ⅜ in. thick if more than one coat is used. Each coat should be applied before the preceding one has attained its final set. Good workmanship is essential and the use of a wooden float is necessary in order to obtain a dense, impermeable coating. As ordinarily applied, the finished coating is about ¾ in. thick. The cost of ¾-in. plaster, applied as above, will be about six cents per square foot.

MEMBRANES.

Membrane waterproofing consists of the formation of a mat or covering of waterproofing material over the surface to be waterproofed, made up of a number of layers of membrane united by a cementing material. Being somewhat elastic and independent of the movement of the surface, this method offers a protection from the seepage of water through expansion or contraction joints and cracks in the masonry which cannot be secured by any other. For this reason it is largely used for waterproofing subways, arches, solid floor bridges, retaining walls, basements, pits, etc. It is also largely used in important structures in connection with some integral form of waterproofing as a precaution against seepage of water through cavities that may occur in the masonry.

Although waterproofing by the membrane method has been unsuccessful in many cases and many reports of failures are returned by the railroad companies, the better methods of membrane waterproofing now in use are giving excellent results. Often on railroad bridge floors the waterproofing is destroyed by the creeping of its protection under traffic; on arches or sharply inclined surfaces by its movement due to the settlement of the fill. In many cases the labor employed is quite unskilled and the results are obviousy poor.

Another factor in the success or failure of waterproofing is the state of the weather. In cold weather the heated materials cool too rapidly. In very damp or rainy weather it is impracticable to make a good job of waterproofing, unless some protection from the weather is provided. Other causes of failure are the lack of free working space and interuption by traffic. Any of these causes may lead to failure, even with the best materials.

Materials.

The materials of membrane waterproofing and the combinations that have been used most successfully by the various railroads are as follows:

Felts and Burlaps.

Wool felt impregnated with either asphalt or coal tar pitch.

Wool felt impregnated with either asphalt or coal tar pitch and skin coated with the same material.

Wool felt impregnated with coal tar pitch and reinforced with a thickness of cotton drilling cemented to the felt with coal tar pitch.

Asbestos felt impregnated with asphalt.

Burlap both plain and impregnated with either coal tar pitch or asphalt.

Cementing Materials.

Mined or lake asphalts.
Petroleum asphalts.
Coal tar pitch.

Combinations.

Two to three layers of felt cemented together, used generally for damp-proofing and for the backs of retaining walls or foundations where no provision for a head of water is necessary.

Four to six layers of felt cemented together, used generally for railroad bridge floors, arches, tunnels, subways and for a protection from a head of water.

To add tensile strength to the waterproofing, the following combinations are commonly used: One middle layer of reinforced felt or burlap and four layers of felt, all cemented together. One layer of felt, two layers of burlap and two layers of felt cemented together, and three layers of burlap and one top layer of felt cemented together.

Combinations of coal tar pitch and asphalt treated felt or asphalt and coal tar treated felt should not be used as the materials will not combine.

In using burlap it is recommended that burlap impregnated with either asphalt or coal tar pitch be used, otherwise, owing to its nature, it is impracticable to prevent the absorption of moisture when the material is exposed to the weather. On the other hand, the treating of burlap promotes the bond and penetration as the treating materials in the burlap are softened on the application of the hot cementing material, and the whole becomes united in one mass.

The use of burlap with cementing material, whose temperature on application exceeds 450 deg. F., is not recommended, as the higher temperatures are likely to result in burning and destruction of the burlap. In many cases it is desirable to bond the waterproofing to the surface. This is not desirable in the vicinity of expansion joints or where there is likely to be a movement of the surface. At such points special provision must be made in the waterproofing to allow for expansion.

To protect the membrane from injury it is necessary to provide a covering of some hard material that cannot be penetrated by ballast, tamping picks nor by sharp stones.

Of the various methods, the following three have been the most widely used:

Brick laid flat in the hot cementing material with joints poured with the same material, or brick laid in cement mortar.

A cement mortar coating about two inches thick, reinforced with wire mesh, forms a good protection and can often be used to better advantage where there is a tendency of the protecting materials to creep. This protection is recommended for arches and tunnels.

A bituminous binder not less than 1¼ in. thick, consisting of asphalt or pitch mixed with sand, gravel or fine crushed stone and applied over the waterproofing, has often been successfully used. If this is used, it should be of such consistency in hot weather as to prevent runs and the stones forcing through the protection to the waterproofing. It is not recommended on steep slopes.

The cost of membrane waterproofing varies greatly with conditions. A five-ply membrane waterproofing, with asphalt-treated felts cemented with asphalt, will cost from 25 cents to 45 cents per sq. ft., including a bituminous binder or brick protection and labor. A five-ply membrane waterproofing, using four layers of coal tar pitch-treated felt and one layer of felt reinforced with cotton drilling, cemented with coal tar pitch, will cost from 20 cents to 35 cents per sq. ft., including bituminous binder or brick protection and labor. A four-ply membrane waterproofing, using one layer of asbestos felt and three layers of impregnated burlap cemented with asphalt, including 1¼-in. thick asphalt mastic protection and labor, will cost from 20 cents to 30 cents per sq. ft.

Cost of asphalt about $30 per gross ton.
Cost of coal tar pitch about $17.50 per gross ton.
Cost of asphalt-treated felts from $1 to $1.25 per 100 sq. ft.
Cost of coal tar pitch-treated felts about 25 cents per 100 sq. ft.
Cost of reinforced felt from $2 to $2.25 per 100 sq. ft.
Cost of asbestos felt about 70 cents per 100 sq. ft.
Cost of brick $8 to $12 per thousand.

INTEGRALS.

The use of some material in small quantities, mixed with the concrete materials in order to make concrete watertight, is generally called the integral method of waterproofing.

The addition of a small amount of fine material to a rich concrete mixture with a well-graded aggregate, decreases the strength of the concrete. The effect upon leaner mixtures is to increase the impermeability of the concrete without decreasing its strength. Fillers used should not only be inert toward the action of the cement, but also to atmospheric conditions and to water. Material containing organic matter should be avoided, owing to its deleterious effect upon the strength of the concrete.

The waterproofing effect of inert fillers depends upon the void-filling quality of the material used and upon the grade of workmanship insisted upon; the addition of a waterproofing compound to the concrete material coupled with poor workmanship will not assure watertight concrete.

When dry compounds are used from 1 to 2½ per cent. of the cement used are recommended by the manufacturers, while for the liquid compounds from 4 to 8 per cent of the amount of water used is recommended by them. The cost of concrete is increased by the addition of such materials from 80 cents to $1.20 per cubic yard for dry compounds and from 50 cents to $1 for the liquid compounds, per cubic yard of concrete.

Compounds which are added to the concrete mixture and which react with certain of the constituents of the cement to form other compounds which will be inert and fill the voids are considered active fillers. In general these materials are soaps and soaponifiable oils. Inasmuch as the waterproofing effect of these materials depends upon a reaction which may or may not take place, objection has been made to their use.

WATERTIGHT CONCRETE CONSTRUCTION.

The results of laboratory experiments, supplemented by many examples from practice, have shown that watertight concrete can be made without the use of coatings, membranes or integral compounds. The question of watertight concrete is a problem of reducing the size and number of voids. Sands contain voids ranging from about 25 to 40 per cent of the total volume of dry loose sand. The proportions of cement to aggregate required to make a mixture of the maximum density with sands of these extreme values, are about 1:1½ to 1:2½. Experience has demonstrated that mortars leaner than this are not suitable for work requiring considerable strength or density, so that the proportions used in ordinary engineering work are sufficiently rich to produce a watertight concrete, provided the aggregates possess the requisite qualities.

The amount of voids in a mixture of aggregate and cement is the least when the cement is just sufficient to fill the voids in the aggregate, since the cement paste itself is less dense than the coarse material of the aggregate. A slight deficiency in cement produces a porous concrete because the unfilled voids are large enough to permit the passage of water, while properly made concrete containing an excess of cement, though it may be of lower density than the former, is impermeable after hardening, since the voids in the cement paste are too small to permit the passage of water. Tests have failed to discover substances which, added to the concrete materials, will increase the density of the cement paste which fills the interstices between the particles of the aggregates, hence it is not believed that improvement as regards impermeability of concrete containing sufficient cement can be made by the addition of any material to the concrete mixture.

In discussing the use of exterior coatings as against impermeable construction, the point is often advanced that although there is no doubt that watertight concrete can be made, the watertightness is of no avail when cracks occur in the structure. The subject of cracking is one of design. Cracks are caused by failure to properly provide for primary stresses to which the structure is subjected, by faulty details, by settlement of foundations, by shrinkage of concrete when hardening in air, and by stresses developed in the concrete due to temperature changes. The first requisite in designing any structure when water is to be kept out from the interior or from beneath, is to provide means of getting rid of the water as directly and as quickly as possible. Methods of providing drainage differ with the class of the structure.

CONCLUSIONS.

(1) Watertight concrete may be obtained by proper design, reinforcing the concrete against cracks due to expansion and contraction, using the proper proportions of cement and graded aggregates to secure the filling of voids and employing proper workmanship and close supervision.

(2) Membrane waterproofing, of either asphalt or pure coal tar pitch in connection with felts and burlaps, with proper number of layers, good materials and workmanship and good working conditions, is recommended as good practice for waterproofing masonry, concrete and bridge floors.

(3) Permanent and direct drainage of bridge floors is essential to secure good results in waterproofing.

(4) Integral methods of waterproofing concrete have given some good results. Special care is required to prop-

erly proportion the concrete, mix thoroughly and deposit properly so as to have the void-filling compounds do the required duty; if this is neglected, the value of the compounds is lost and their waterproofing effect destroyed. Careful tests should be made to ascertain the proper proportions and effectiveness of such compounds.

Integral compounds should be used with caution, ascertaining their chemical action on the concrete as well as their effect on its strength; as a general rule, integral compounds are not recommended, since the same results as to water-tightness can be obtained by adding a small percentage of cement and properly grading the aggregate.

(5) Surface coatings, such as cement mortar, asphalt or bituminous mastic, if properly applied to masonry reinforced against cracks produced by settlement, expansion and contraction, may be successfully used for waterproofing arches, abutments, retaining walls, reservoirs and similar structures; for important work under high pressure of water these cannot be recommended for all conditions.

(6) Surface brush coatings, such as oil paints and varnishes, are not considered reliable or lasting for waterproofing of masonry.

APPENDIX C.

Disintegration of Concrete and Corrosion of Reinforcing Metal.

The subject of the distintegration of concrete leads directly to the study of the causes of disintegration and the means whereby it may be prevented. The corrosion of reinforcing metal confines investigation to a study of reinforced concrete. Inasmuch as corrosion of reinforcing metal ultimately leads to disruption of the surrounding concrete and ordinarily presupposes disintegration of the concrete, the subjects are closely allied.

CONCRETE IN SEA WATER.

Investigations concerning the effect of sea water on concrete immersed for periods up to fifty years or more; of the relative merits of standard Portland cement and Portland cement made with different proportions of its principal constituents, in resisting the disintegrating effect of sea water; of the effect of varying the proportions of cement in the mortar and concrete; of differently graded aggregates; of the addition of various finely ground materials to the cement after burning; of the relative durability of concrete cast in place as compared with concrete blocks allowed to harden before placing in the sea; and of the effect of various materials added to the concrete mixture to produce impermeability and consequent increased durability, have been made in European countries and in America.

Regarding the chemical composition of the cement, the following conclusions are presented:

Cement containing up to 2½ per cent. of SO_3 resists the action of the water fully as well as cement with lower SO_3 content.

While all the hydraulic cements now in use are liable to decomposition in sea water, Portland cement is the one to be preferred in every respect.

High iron Portland cement and puzzolan cement have failed to show superiority over standard Portland cement in resisting the distintegrating effect of sea water.

In general the richer mixtures have been found to offer better resistance to the attack of sea water. Proportions recommended for mortars are those with one part cement to one part sand up to one part cement to two parts sand. In the use of reinforced concrete for maritime works, it is advisable to employ larger proportions of cement than are usual for similar works in fresh water.

It has been found that the addition of puzzalana to Portland cement increases the resistance of the resulting mortar or concrete to the distintegrating effect of sea water.

No results of practical working tests have demonstrated that the effect of any material in reducing permeability is other than mechanical, i. e., to supply a deficiency in fine material in a poorly graded concrete mixture.

Allowing the concrete to harden under favorable conditions before exposure to the action of sea water greatly increases its resistance to attack by the sea water and is recommended wherever possible.

When concrete is deposited under sea water, such precaution should be observed as will prevent the washing of the cement from the mixture.

Forms should be so tight as to prevent the entrance of sea water after depositing the concrete, in order that a smooth, dense surface may be obtained.

The combined effect of freezing and of sea water is noted on marine structures in northern latitudes between high and low tide levels. Under these conditions the distintegrating effects are particularly severe.

Dense, properly hardened concrete is not affected by the action of sea water. Where the concrete is porous, however, it is likely to be damaged by frost action, especially between tides. There is no evidence, however, that porous concrete is damaged by sea water in latitudes where there is no frost.

The making of a dense, impermeable concrete by the use of a well-graded aggregate, rich mixture, proper consistency and good workmanship, and allowing the concrete to harden under favorable conditions before being exposed to the action of sea water, is generally conceded to be an efficient means of satisfactorily insuring the preservation of concrete in maritime works.

CONCRETE SUBJECTED TO THE ACTION OF WATER CONTAINING ALKALIES.

Concrete in which poor aggregates and lean mixtures have been used and in which the material has been carelessly placed, when coming in contact with alkali seepage may be affected thereby.

The aggregates should be composed of materials inert to alkalies present in the water. A chemical examination of the sand from country known to contain alkaline soils is recommended.

Water containing substances known to react with the elements of the cement should be kept from coming in contact with concrete until the latter has thoroughly hardened.

Care should be taken to provide a smooth surface and sufficient slope to the extrados of the arch of tunnel linings when the ground water level lies below the tunnel grade to facilitate the flow of seepage water to the sides. The backfilling over the arch should consist of porous material, such as coarse, crushed stone, for the same reason. Side-drains should be used where necessary and connected with an underdrain, which should be provided in all cases.

The alkalies which are most active in causing disintegration of concrete when allowed to penetrate into the interior of the mass, are the sulphates of sodium and magnesium.

The measures to be used in making concrete which is to be exposed to the action of these deteriorating agencies in order to prevent disintegration are the same as recommended for sea water construction.

MISCELLANEOUS CAUSES OF DISINTEGRATION.

Cinders give unsatisfactory results in concrete, especially if there is much coke or porous material present. Such cinders may be improved if allowed to weather, with occasional washing until the ferrous iron and sulphur have been oxidized and leached out.

Cinder concrete in roofing slabs exposed to the action of locomotive gases is not an efficient protection for reinforcing metal, which has been found to corrode and cause the disintegration of the slab.

Freshly made concrete surfaces in contact with smoke gases at temperatures below 45 deg. F. have failed to harden properly, and experiments indicate that under such conditions the cement is acted upon by the gases. It has therefore been recommended that when heating is done by means of open fires, higher temperatures should be maintained.

CORROSION OF REINFORCING METAL.

Tests and experience have proved that steel embedded in dense concrete will not corrode, when located either above or below fresh or sea water level. Concrete, in order to be an efficient protection to steel, must be rich in cement and mixed to such a consistency as to flow around and completely coat the reinforcing metal.

CONCLUSIONS.

Concrete exposed to the action of sea water, or in contact with alkali waters, or exposed to gases containing sulphur, or in which reinforcing metal is embedded, should be dense, rich in Portland cement and allowed to harden under favorable conditions before exposure to the conditions stated.

Concrete in contact with alkali waters should be made with aggregates inert to the alkalies in the water.

Cinders should not be used for concrete in which reinforcing metal is embedded.

Reinforcing metal should not be painted, but should be thoroughly covered and protected with concrete when in place.

Discussion on Masonry.

G. H. Tinker, chairman, presented the report, reading conclusion one, under Appendix A, which was adopted. Conclusion

2 was referred back to the committee and conclusions 1, 3, 4, 5 and 6 were adopted and are to be published in the Manual.

Mr. Tinker: The committee wishes to offer a revision of Conclusion 1 in Appendix C, as follows: "Concrete to be exposed to the action of sea water, or alkali waters, or gases containing sulphur, or in which reinforcing metal is embedded, should be dense, rich in Portland cement and allowed to harden under favorable conditions before such exposure." Also an amendment to Conclusion 2: "Concrete to be in contact with alkali waters should be made with aggregates inert to the alkalis in the water."

(The four conclusions were then adopted and are to be published in the Manual.)

Mr. Tinker: During the next year we expect to get a start on some of the experiments on earth retaining walls. We also intend to revise the specifications for concrete and reinforced concrete, not very extensively, but in some small parts. The subject of specifications for Portland cement and the method of testing cement will be largely overhauled by the committees having such matters in charge.

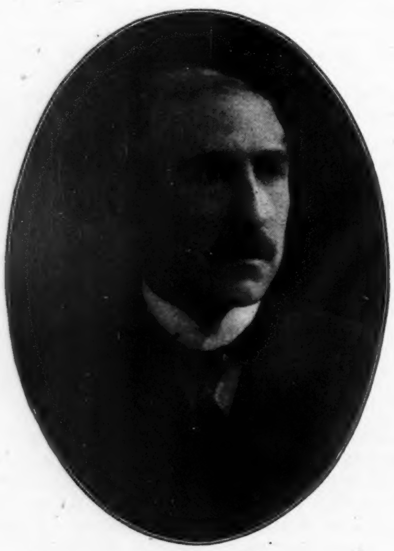
Hunter McDonald (N. C. & St. L.): I would suggest that the committee be instructed to look into the matter of facing concrete having a large amount of water in it.

Mr. Safford: I think that the committee should continue their investigations and see if it is not possible to get a set of specifications or rules regarding the waterproofing of bridge floors which shall be acceptable and which the majority of the members of the association will use.

TRACK

MAIN LINE TURNOUTS AND CROSSOVERS.

The committee prepared typical plans for Nos. 8, 11 and 16 main line crossovers. It also made a study of



J. B. JENKINS,
Chairman Committee on Track.

double-slip crossings, obtaining data as to the practice and standards of various railroads and manufacturers. The committee is studying and reported progress on plans for double crossovers.

SPEEDS OF TRAINS ON CURVES AND TURNOUTS.

The committee made a study of speeds through turnouts and around curves, with calculations and prepared diagrams showing the results of these calculations.

Heights of centers of gravity of recently constructed engines and tenders are given in the following tables, furnished by the Baldwin and American companies.

AMERICAN LOCOMOTIVE COMPANY.

VERTICAL CENTER OF GRAVITY OF ENGINES

Order No.	Road	Class	Weight	Cylinders	Driving Wheel Diam.	Center of Gravity from Rail
S 846	Missouri Pac..	462	256,000	26 x26″	73″	76½″
S 831	Missouri Pac...	282	275,000	27 x30″	63″	71″
B 1234	Missouri Pac..	280	209,600	22 x30″	63″	72″
S 310	B. & O.........	462	229,500	22 x28″	74″	70″
S 496	N. Y. C.......	280	236,000	23 x32″	63″	72″
S 461	L. S. & M. S..	462	261,500	22 x28″	79″	75½″
S 203	Grand Trunk..	460	182,000	20 x26″	73″	64½″
S 42	B. & O.........	280	186,000	21 x30″	57″	68½″
S 286	Pennsylvania..	262	#1 230,000 #2 234,500	22½x28″	80″	74½″
P 405	B. & O.........	280	193,500	22 x28″	56″	60½″
S 351	M. & St. L....	260	150,500	20 x26″	64″	60½″
S 73	B. & O.........	442	180,000	22 x26″	80″	70½″

VERTICAL CENTER OF GRAVITY OF TENDERS

Order No.	Road	Capacity	Tank Type	Center of Gravity
S 848	Erie..................	9000	Vanderbilt	76½″
J 1720	Erie..................	8500	Water Bottom	77″
S 695	Experimental........	8000	Water Bottom	70″

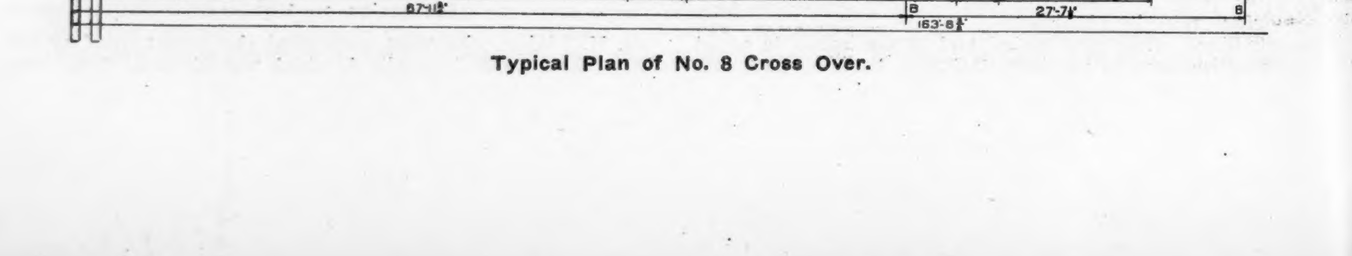
THE BALDWIN LOCOMOTIVE WORKS.

APPROXIMATE HEIGHT OF CENTER GRAVITY OF STANDARD GAGE LOCOMOTIVES AND TENDERS RECENTLY CONSTRUCTED

Type of Locomotive	Engine in Working Order		Tender Loaded	
	Weight Pounds	Height C. of G. Inches	Weight Pounds	Height C. of G. Inches
4-6-2	267,000	80	147,000	60
2-8-0	217,000	74	177,000	60
2-8-2	265,000	78	167,000	57
2-8-2	275,000	76	184,000	62
2-8-2	284,000	78	167,000	65
2-8-2	286,000	75	154,000	55
2-8-2	310,000	75	175,000	56
2-8-2	322,000	76	157,000	62
2-10-2	293,000	78	185,000	62
2-10-2	356,000	77	160,000	55
0-6-6-0	350,000	77	140,000	62
0-8-8-0	409,000	84	170,000	61
2-8-8-0	450,000	80	154,000	64

The engine has a lateral swing or play due to compression of springs, play on axle, difference between gages of wheels and track, worn flanges, worn rail and widening of gage of track on curves, although the last factor is usually more than neutralized by the distance the center of the wheel-base is held away from the outer rail by curvature.

Although the flange of the rear wheel of an engine traveling at slow speed is never observed to be in contact with the outer rail when there is any lateral play, it would be unsafe to assume that such were the case at speeds



Typical Plan of No. 8 Cross Over.

high enough to be near the limit of safety, and it is entirely possible that the line of the wheels may at times coincide with a chord of the rail drawn from the point of contact of the front wheel to that of the read wheel. Hence is has been assumed that the minimum distance that the center of the outer wheel-base is held away from the outer rail equals the middle ordinate of a curve whose chord equals the length of wheel-base.

Under compression of springs, the upper part of the engine revolves about a horizontal central axis about 40 in. above the rail; the maximum vertical movement of the springs from normal position is about ¼ in., at a distance of about 2 ft. 4 in. from the center of the engine; the resulting swing from one side to the other of a point in the vertical axis of the engine, 84 in. above the rail, is

$$2 \times \frac{84\text{-}40}{28} \times \tfrac{1}{4}\text{ in.} = \tfrac{11}{14}\text{ in.} = \tfrac{13}{16}\text{ in.}$$

Gage of wheels back to back of flanges	53⅜ in.
Add two flanges of minimum thickness	2
Minimum gage of wheels, front to front of flanges	55⅜ in.
Gage of track	56½
Maximum play between worn wheels and standard gage track	1⅛ in.
Play on axle	58
Total lateral play not affected by degree of curve	$2\frac{9}{16}$ in.

The distance B, from the center of gravity to the axis of the track, equals ½ of $2\frac{9}{16}$ in., plus half the widening of gage due to worn rail, plus half the widening of gage for curvature, less the middle ordinate of the curve for a length equal to the wheel-base.

For example, with a 12-foot wheel base:

When D = 1 degree, $B = 1\frac{9}{32}$ in. + ¼ in. + 0 in. − $\frac{1}{32}$ in. = 1½ in.
" D = 4 degrees, $B = 1\frac{9}{32}$ in. + ¼ in. + 0 in. − $\frac{5}{32}$ in. = 1⅜ in.
" D = 8 degrees, $B = 1\frac{9}{32}$ in. + ¼ in. + 0 in. − $\frac{5}{16}$ in. = $1\frac{7}{32}$ in.
" D = 15 degrees, $B = 1\frac{9}{32}$ in. + ¼ in. + ¼ in. − $\frac{9}{16}$ in. = $1\frac{7}{32}$ in.
" D = 19 degrees, $B = 1\frac{9}{32}$ in. + ⅛ in. + ⅜ in. − $\frac{23}{32}$ in. = $1\frac{1}{16}$ in.
" D = over 19 degrees, B = less than

Thus, B varies from a possible value of 1½ in. for a 1-degree curve to a possible $1\frac{7}{32}$ in. for an 8-degree curve, remains constant on account of widening of gage for curvature up to 15 degrees and then decreases.

The value of G may also vary from 56½ in., the standard gage, to 57½ in.; but under the conditions which will give B its maximum values G will have the following values:

D = 1 degree to 8 degrees .... G = 57 in.
D = 15 degrees or over .... G = 57½ in.

It might appear at first thought that a wider gage would increase the stability of an engine, and that, therefore, the

Height of Center of Gravity 84 in.
Resultant of Forces through Gage Line

Degree of Curve	Elevation in Inches								
	0	1	2	3	4	5	6	7	8
1°	165.9	170.9	175.8	180.6	185.3	190.0	194.7	199.4	204.0
1°30′	135.5	139.5	143.5	147.4	151.3	155.1	159.0	162.8	166.5
2°	117.3	120.8	124.3	127.7	131.1	134.3	137.7	141.0	144.2
2°30′	104.9	108.1	111.2	114.2	117.2	120.1	123.1	126.1	129.0
3°	95.8	98.7	101.5	104.3	107.0	109.7	112.4	115.1	117.8
3°30′	88.7	91.3	94.0	96.5	99.1	101.5	104.1	106.6	109.0
4°	83.0	85.4	87.9	90.3	92.7	95.0	97.4	99.7	102.0
4°30′	78.2	80.6	82.9	85.1	87.4	89.6	91.8	94.0	96.2
5°	74.2	76.4	78.6	80 8	82.9	85.0	87.1	89.2	91.2
6°	67.7	69.8	71.8	73.7	75.7	77.6	79.5	81.4	83.3
7°	62.7	64.6	66.4	68.3	70.1	71.8	73.6	75.3	77.1
8°	58.7	60.4	62.1	63.8	65.5	67.2	68.8	70.5	72.1
9°	55.3	57.0	58.6	60.2	61.8	63.3	64.9	66 4	68.0
10°	52.5	54.0	55.6	57.1	58.6	60.1	61.6	63.0	64.5
12°	47.9	49.3	50.7	52.1	53.5	54.8	56.2	57.5	58.9
14°	44.3	45.7	47.0	48.3	49.5	50.8	52.0	53.3	54.5
16°	41.5	42.7	43.9	45.1	46.4	47.5	48.7	49.8	51.0
18°	39.1	40.3	41.4	42.6	43.7	44.8	45.9	47.0	48.1
20°	37.1	38.2	39.3	40.4	41.4	42.5	43.5	44.6	45.6
25°	33.2	34.2	35.2	36.1	37.1	38.0	38.9	39.9	40.8
30°	30.3	31.2	32.1	33.0	33.8	34.7	35.5	36.4	37.2

Speeds of Trains on Curves.

minimum value of G should be used in all calculations, in order to keep on the safe side. Such would be the case if the gage of the wheels were widened at the same time as the gage of the track, but a little consideration will show that the widening of the gage does not affect the stability of the engine, either one way or the other, when it is at the point of overturning, while a wider gage actually decreases the stability of the engine when the resultant of forces falls within the gage line.

SPEED AND UNBALANCED ELEVATION FOR CURVATURE.

The comfort of a passenger on a train, which passes over a curve or through a turnout at high speed, is not

Height of Center of Gravity 84 in.
Resultant through Edge of Middle Third

Degree of Curve	Elevation in Inches								
	0	1	2	3	4	5	6	7	8
1°	90.3	98.4	105.9	112 9	119.6	125.9	132.0	137.9	143.4
1°30′	73.7	80.3	86.4	92.2	97.6	102.8	107.8	112.6	117.2
2°	63.9	69.6	74.9	79.8	84.5	89.0	93.3	97.5	101.5
2°30′	57.1	62.2	67.0	71.4	75.6	79.6	83.5	87.2	90.8
3°	52.1	56.8	61.1	65.2	69.0	72.7	76 2	79.6	82.9
3°30′	48.3	52.6	56.6	60.3	63.9	67.3	70.6	73.7	76.7
4°	45.2	49.2	52.9	56.5	59.8	62.9	66.0	68.9	71.7
4°30′	42.6	46.4	49.9	53.2	56.4	59.4	62.2	65.0	67.7
5°	40.4	44.0	47.3	50.5	53.5	56.3	59.0	61.7	64.2
6°	36.9	40.2	43.2	46.1	48.8	51.4	53.9	56.3	58.6
7°	34.1	37.2	40.0	42.7	45.2	47.6	49.9	52.1	54.3
8°	31.9	34.8	37.4	39.9	42.3	44.5	46.7	48.7	50.8
9°	30.1	32.8	35.3	37.6	39.8	42.0	44.0	46.0	47.8
10°	28.6	31.1	33.5	35.7	37.8	39.8	41.7	43.6	45.4
12°	26.1	28.4	30.6	32.6	34.5	36.3	38.1	39.8	41.4
14°	24.1	26.3	28.3	30.2	31.9	33.6	35.3	36.8	38.4
16°	22.6	24.6	26.5	28.2	29.9	31.5	33.0	34.5	35.8
18°	21.3	23.2	25.0	26.6	28.2	29.7	31.1	32.5	33.8
20°	20.2	22.0	23.7	25.2	26.7	28.1	29.5	30.8	32.1
25°	18.1	19.7	21.2	22.6	23.9	25.2	26.4	27.6	28.7
30°	16.5	18.0	19.3	20.6	21.8	23.0	24.1	25.2	26.2

Speeds of Trains on Curves.

dependent on the height of the center of gravity of the engine which draws the train, or of the car in which he is riding, nor is it dependent on the point where the resultant of forces intersects the plane of the track. But the comfort of the passenger is much affected by the condition of the track in the matter of surface and line, and the disturbed equilibrium of the passenger due to centrifugal force uncompensated by the cant of the track. The relation of speed to the condition of the track cannot be reduced to formula, tabulated nor shown on a diagram, but the relation of equilibrium to speed can very readily be shown.

There are nearly as many opinions as there are individuals as to what constitutes a comfortable speed on curves; but by tabulating speeds which will produce a certain fixed degree of disturbance of equilibrium, we can

Three Inches of Unbalanced Elevation.
Those Speeds of Trains on Curves having an Elevation of 3 Inches less than the Theoretical Elevation.
All Heights of Center of Gravity.

Degree of Curve	Actual Elevation in Inches								
	0	1	2	3	4	5	6	7	8
1°	67.5	78.0	87.2	95.6	103.4	110.7	117.6	124.1	130.4
1°30′	55 1	63.7	71.2	78.1	84.4	90.4	96.0	101.3	106.5
2°	47.7	55 1	61.7	67.6	73.1	78.3	83.1	87.8	92.2
2°30′	42.7	49.3	55.2	60.5	65.4	70.0	74.3	78.5	82.5
3°	39.0	45.0	50.4	55.2	59.7	63.9	67.9	71.7	75.3
3°30′	36.1	41.7	46.6	51.1	55.3	59.2	62.8	66.3	69.7
4°	33.7	39.0	43.6	47.8	51.7	55.3	58.8	62.1	65.2
4°30′	31.8	36.8	41.1	45.1	48.8	52.2	55.4	58.5	61.5
5°	30.2	34.9	39.0	42.8	46.2	49.5	52.6	55.5	58.3
6°	27.6	31.8	35.6	39.0	42.2	45.2	48.0	50.7	53.2
7°	25.5	29.5	33.0	36.1	39.1	41.8	44.4	46.9	49.3
8°	23.9	27.6	30.8	33.8	36.6	39.1	41.6	43.9	46.1
9°	22.5	26.0	29.1	31.9	34.5	36.9	39.2	41.4	43.5
10°	21.3	24.7	27.6	30.2	32.7	35.0	37.2	39.3	41.2
12°	19.5	22.5	25.2	27.6	29.9	32.0	33.9	35.8	37.6
14°	18.0	20.8	23.3	25.6	27.6	29.6	31.4	33.2	34.8
16°	16.9	19.5	21.8	23.9	25.9	27.7	29.4	31.0	32.6
18°	15.9	18.4	20.6	22.6	24.4	26.1	27.7	29.2	30.7
20°	15 1	17.4	19.5	21.4	23.1	24.7	26.3	27.8	29.2
25°	13.5	15.6	17.4	19.1	20.7	22.1	23.5	24.8	26.1
30°	12.3	14.2	15.9	17.5	18.9	20.2	21.5	22.6	23.8

Speeds of Trains on Curves.

at least furnish a basis for comparison between speed and comfortable riding.

If the angle of the resultant forces with the axis of the track is 3 deg., the track will lack sufficient cant to neutralize the centrifugal force by 3 deg.; a difference of

3 deg. in the cant of the track is very closely equivalent to a difference of 3 in. in elevation of the outer rail. Hence, if the amount of discomfort can be measured by the degree of angle, which the resultant of forces makes with the axis of the car, it can be measured by number of inches of unbalanced elevation. In other words, a passenger riding over track elevated 1 in. at a speed requiring an elevation of 4 in., should experience the same amount of discomfort as when riding over track elevated 7 in. at a speed requiring an elevation of 10 in.

The committee has calculated tables of speeds of trains

Height of Center of Gravity 84 in.
Resultant of Forces through Gage Line.

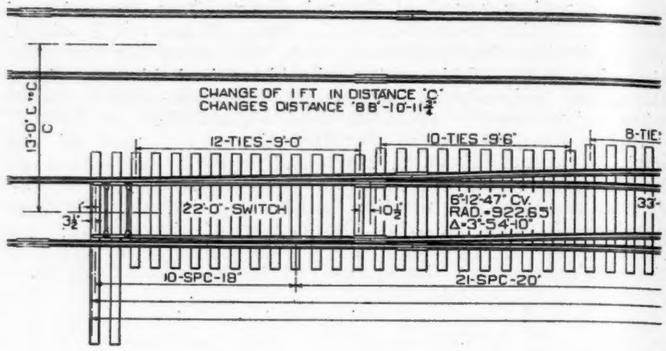
Frog No.	Degree of Lead Curve	Length of Switch	Elevation in Inches			
			0	1	2	3
4-6		11	34.1	35.1	36.1	37.1
4	53°42′24″		22.6	23.3	24.0	24.6
5	33°19′57″		28.7	29.6	30.4	31.3
6	21°43′04″		35.9	37.0	38.0	39.0
7-10		16.5	51.1	52.7	54.2	55.7
7	15°52′29″		41.7	43.0	44.2	45.4
8	11°46′27″		48.4	49.8	51.2	52.6
9	9°28′42″		53.9	55.5	57.1	58.7
9½	8°14′45″		57.8	59.5	61.2	62.9
10	7°15′18″		61.6	63.5	65.3	67.1
11-14		22	68.2	70.3	72.2	74.2
11	6°12′47″		66.6	68.6	70.5	72.4
12	5°12′59″		72.7	74.8	77.0	79.1
15-24		33	102.3	105.4	108.4	111.3
15	3°17′10″		91.1	94.3	97.0	99.7
16	2°52′59″		97.7	100.6	103.5	106.4
18	2°14′31″		110.8	114.1	117.4	120.6
20	1°45′32″		125.1	128.9	132.5	136.2
24	1°10′21″		153.3	157.9	162.4	166.8

Speeds of Trains Through Turnouts.

Height of Center of Gravity 84 in.
Resultant Through Edge of Middle Third.

Frog No.	Degree of Lead Curve	Length of Switch	Elevation in Inches			
			0	1	2	3
4-6		11	18.6	20.2	21.8	23.2
4	53°42′24″		12 3	13.4	14.4	15.4
5	33°19′57″		15.6	17.0	18.3	19.5
6	21°43′04″		19.5	21.3	22.9	24.4
7-10		16.5	27.8	30.3	32.6	34.8
7	15°52′29″		22.7	24.7	26.6	28.4
8	11°46′27″		26.3	28.7	30.9	32.9
9	9°28′42″		29.3	32.0	34.4	36 7
9½	8°14′45″		31.4	34.3	36.9	39 3
10	7°15′18″		33.5	36.5	39.3	41.9
11-14		22	37.1	40.4	43 5	46.4
11	6°12′47″		36.2	39.5	42.5	45.3
12	5°12′59″		39.5	43 1	46.4	49.4
15-24		33	55.7	60.7	65.3	69.6
15	3°17′10″		49.8	54.3	58.4	62.3
16	2°52′59″		53.2	57.9	62.4	66.5
18	2°14′31″		60.3	65 7	70.7	75.4
20	1°45′32″		68.1	74.2	79.8	85.1
24	1°10′21″		83.4	90.9	97.8	104.3

Speeds of Trains Through Turnouts.



through curves and turnouts with unbalanced elevations of 3 in.

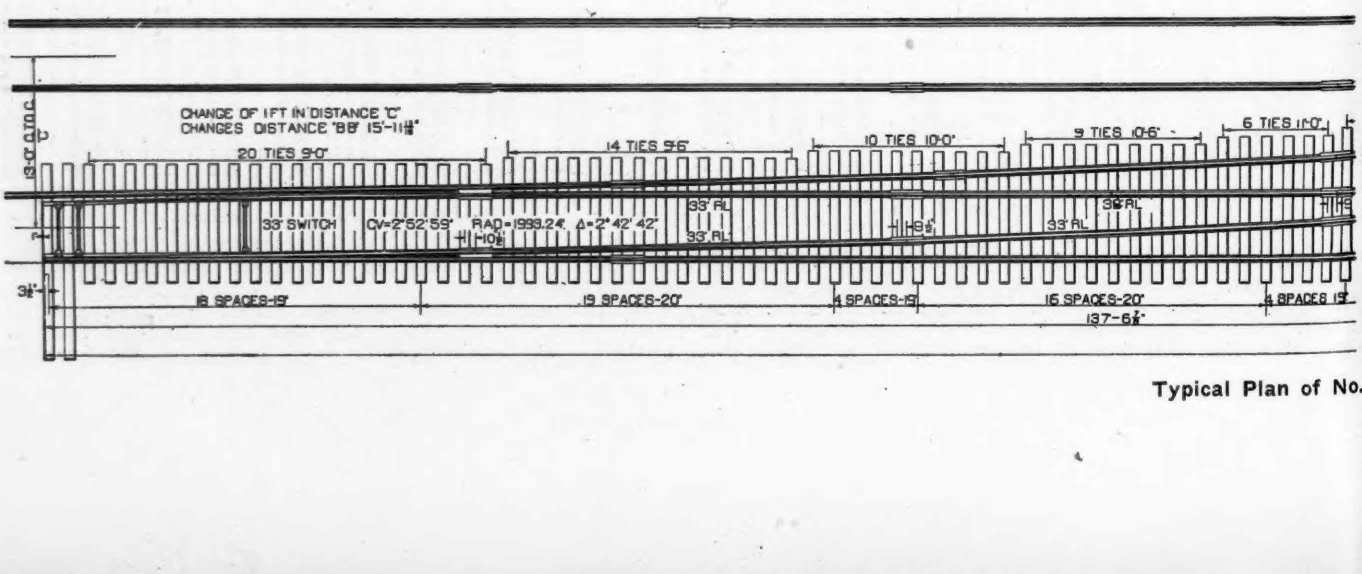
The motion through a straight switch-point being angular, there can be no direct comparison of speed through the switch-point with that through the lead curve. In order to give a rough basis for comparison between the various switch-points and the various lead curves, the speeds through the switch-points are figured for curves whose central angle equals the switch angle, and the length of whose chord equals the length of switch-point. On the above basis, with a wheel-base or truck-center distance equal to or longer than the switch-point, the rate of turning would equal that through the lead curve.

Three Inches of Unbalanced Elevation.
All Heights of Center of Gravity.
Those Speeds of Trains through Turnouts having an Elevation of 3 Inches less than the Theoretical Elevation.

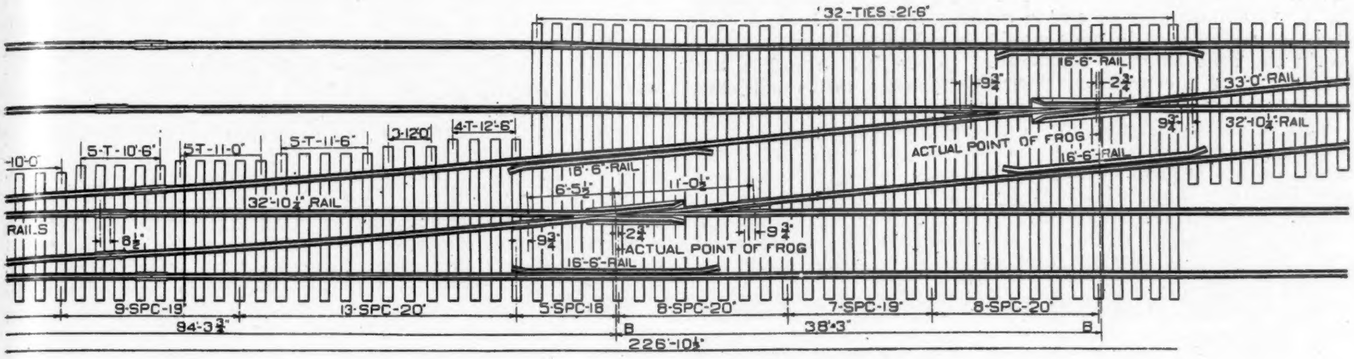
Frog No.	Degree of Lead Curve	Length of Switch	Actual Elevation in Inches			
			0	1	2	3
4-6		11	13.9	16.0	17.9	19.6
4	53°42′24″		9.2	10.6	11.9	13.0
5	33°19′57″		11.7	13.5	15.1	16.6
6	21°43′04″		14.6	16.9	18.9	20.7
7-10		16.5	20.8	24.0	26.9	29.5
7	15°52′29″		17.0	19.6	21.9	24.0
8	11°46′27″		19.7	22.7	25.4	27.9
9	9°28′42″		21.9	25.3	28.3	31.1
9½	8°14′45″		23.5	27.1	30.4	33.3
10	7°15′18″		25.1	29.0	32.4	33.5
11-14		22	27.7	32.0	35.9	39.3
11	6°12′47″		27.1	31.3	35.0	38.4
12	5°12′59″		29.5	34.1	38.2	41.9
15-24		33	41.6	48.1	53.8	59 0
15	3°17′10″		37.2	43.0	48.1	52.8
16	2°52′59″		39.7	45 9	51.4	56.3
18	2°14′31″		45.1	52.1	58.3	63.9
20	1°45′32″		50.9	58.8	65.8	72.1
24	1°10′21″		62.3	72.0	80.6	88.3

Speeds of Trains Through Turnouts.

By dividing the speeds in the accompanying tables by the frog numbers, the result from each table is found to be nearly a constant. Hence, when the height of center of gravity is 84 ins. and the elevation no in., the speeds have the following simple arithmetical relations to the frog numbers when the turnouts are level:



Typical Plan of No.



Typical Plan of No. 11 Cross Over.

Resultant through gage line—speed = 6.1 N ±.
Resultant through edge of middle third—speed = 3.3 N ±.
Three inches unbalanced elevation—speed = 2.46 N ±.

Other equally simple relations can be figured for other heights of center of gravity. The speed for three inches of unbalanced elevation is not affected by the height of center of gravity.

As nearly as can be compared (by assuming the switch-point as a chord of a curve whose central angle equals the switch angle) the corresponding speeds through the switches are 3.1 S, 1.69 S and 1.26 S, respectively, in which S is the length of the switch-point. On such an assumption the length of the switch-point should approximate double the frog number.

Height of Center of Gravity 84 in.
Resultant Through Points at Varying Distances from Center Line.

Frog No.	Length of Switch	Distance of Resultant from Center Line of Track						
		2"	4"	6"	8"	10"	12"	14"
4-6	11	4.6	10.4	13.9	16.7	19.1	21.3	23.2
4		3.1	6.9	9.2	11.1	12.7	14.1	15.4
5		3.9	8.7	11.7	14 1	16.1	17.9	19.5
6		4.9	10.9	14.6	17.6	20.1	22.4	24.4
7-10	16.5	7.0	15.6	20.9	25.1	28.7	31.9	34.8
7		5.7	12.7	17.0	20.5	23.4	26.0	28.4
8		6.6	14.7	19 7	23.7	27.1	30.1	32.9
9		7.3	16.4	22.0	26.4	30.2	33.6	36.7
9½		7.9	17.6	23.6	28.4	32.4	36.0	39.3
10		8.4	18.7	25.2	30.2	34.6	38.4	41.9
11-14	22	9.3	20.7	27.8	33.5	38.3	42 5	46.4
11		9.1	20.3	27.2	33.4	37.4	41 5	45.3
12		9.9	22.1	29.7	35.6	40.8	45.3	49.4
15-24	33	13.9	31.1	41.8	50.2	57.4	63.8	69.6
15		12.5	27.9	37.4	44.9	50.2	57.1	62.3
16		13.3	29.7	39.9	47.9	54.8	60.9	66.5
18		15.1	33.7	45 2	54.3	62.2	69.1	75.4
20		17.0	38.1	51.1	61.4	70.2	78.0	85.1
24		20.9	46.6	62.6	75.2	86.0	95.6	104.3

Speeds of Trains Through Level Turnouts.

The assumption, for the purpose of comparison, that a switch-point is equivalent to a curve of equal length subtending an angle equal to the switch angle is a purely arbitrary one; it would be true only if the curve were exceedingly kinky and consisted of short tangents, whose lengths equaled the lengths of switch-point. Such an assumption is commonly made, however, evidently under the belief that the center of gravity of the engine reverses a more or less regular curve in the direction of the deflection of the switch-point. It does traverse a curve, it is true; but the direction of the curve is opposite to that of the switch-point; in other words, the curve is concave to the rail.

The middle ordinate of the curve traversed by the middle point in the wheel-base is equal to half the length of wheel-base times the difference between the tangent and the sine of half the switch angle.

The middle ordinate of this curve is so small that the path traversed by any point in the engine, in passing over a switch-point, can be considered as a straight line. Therefore, it is not a curved, but an angular motion with which we have to deal at the switch-point. The reactions at the switch-point are rather complex, consisting of both static and dynamic forces.

Horizontal Thrust at Switch-Point, Due to Friction.

First, there is a static force in the form of a horizontal thrust, due to the switch-point forcing the engine to move at an angle with the direction of rotation of the wheels, or at an angle with the line of the wheel-base. This probably causes a slipping of all wheels, excepting the rear outside or the rear inside wheel, depending on whether the engine is exerting tractive force or not. This horizontal force will vary with the length of wheel-base and with the number of drivers. At the speed of 60 M. P. H. the average sliding motion is at a velocity of only 0.9 M. P. H. At the moment the sliding begins the friction to be overcome is the friction of repose. The co-efficient of friction of repose between steel tires and steel rails is approximately 0.25. After the sliding begins the co-efficient wil drop somewhat, but seldom below that for a velocity of 1 M. P. H.

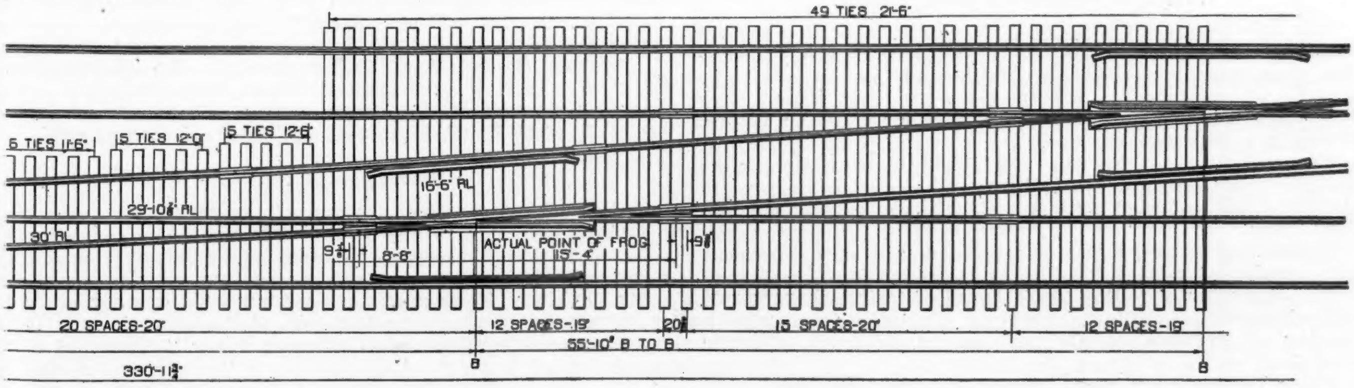
At the moment sliding begins, which is when the front drivers strike the point of a facing-point switch or the stock rail of a trailing-point switch, the horizontal static pressure on the rail in this particular case will be approximately 0.57×0.25 W or T = 0.14 W, in which T is the approximate horizontal static pressure, and W is the weight on drivers.

T will vary somewhat with the type of engine, but will probably never exceed 0.19 W.

In addition to the above static pressure there is a dynamic force, due to the impact of the engine against the stock rail or switch-point, which is being studied by your committee, and will be made the subject of a future report.

ECONOMICS OF TRACK LABOR.

The sub-committee assigned to the subject of Economics of Track Labor has now been in existence for two years.



16 Cross Over.

When it was created, a defined program was prepared, calling for a systematic plan of action embracing some nineteen subjects, of which certain ones would be selected for each year's work, the idea being to look ahead to the future and to not lose sight of the relation existing between these subjects, many of them having defined relations.

The subjects assigned for this year's work were:

(1) The consideration of the idea of extending the scope of duties of a section foreman to embrace certain other works now generally handled by other classes of labor in an endeavor to effect the following:

(a) A saving due to the lost motion of mechanics traveling great distances to perform very simple work, resulting in unnecessary cost.

(b) A saving in delay in getting more prompt action in such work.

(2) The study and development of a system for equating track values to enable:

(a) A more efficient track maintenance as a result of establishing accurate units of service required.

(b) A more equitable method of apportioning moneys for track maintenance.

Subject I.

The sub-committee decided to put out a number of inquiries to determine what had been done by other roads in this connection, and circulars were sent out to the membership. In this circular opinions were also requested upon the general proposition, and a summary of the replies is attached hereto, marked Exhibit "A."

In addition to the information furnished by replies, one of the members, E. T. Howson, has personally canvassed a number of roads, which have shown interest in this proposition, and has prepared an article descriptive of the results obtained. Only three railroads have made a real test of the idea. Some others have tried it to a limited extent, but so far it has had very little trial. The results obtained by the three roads which have made an application of the idea vary considerably, but it will be noted that in the case of the road which found the trial unsatisfactory, the test was started with apparently little preparation and did not extend over a long enough time to really demonstrate it.

The idea is purely an economic one, its purpose being to eliminate the wasteful expenditure due to men traveling long distances to do work, which, while possibly falling under the direction of men specially skilled, yet not beyond the power of an intelligent man of most any experience with ordinary tools. The idea does not involve an immediate change to the condition where the section foreman will be charged with the entire duties of a branch of service, such as suggested, but, if practicable at all, must be started in a very limited way and developed gradually.

Some of the replies state this suggestion calls for a higher class of man—a much broader scope of education, and the class of man now generally found for section foreman is not capable of the enlarged service. A number of the replies indicate that the idea is entirely practicable and can be worked out to advantage. The thought may lead to a great change in organization whereby the track foreman may become extinct and in his place may appear a roadway foreman in charge of track, bridges, ordinary rough building work, ordinary water service, ordinary signal repairs, etc. It is not known to what extent the idea is possible of development, but it warrants careful consideration. The committee recommends continuing the study of the results to be obtained by the roads engaged in the experiment, and that it warrants very careful consideration and experiment by members of the track committee.

Subject II—Equating Track Values.

The sub-committee in the first consideration of this subject came to the conclusion that in the absence of any information upon the subject the basis of the study would have to be a series of experiments. Inquiry developed that while a very few roads had tried to work out a plan for equating values, it was in a very general way.

One exception to the rule was found in the case of the Baltimore & Ohio, which has developed a very complete and elaborate units of work system which has been quite successfully tried.

The factors entering into this problem are very numerous and consist of generally: Character of traffic, quantity of traffic, character of rolling stock, speed of trains, character of rail, character of ballast, character of roadbed, alinement, number of switches, number of feet of sidetrack, climatic conditions, etc.

These factors vary more or less between different parts of the country, and it is very doubtful if any results can be worked out which could be accepted everywhere, and in all probability it will always have to be a more or less local proposition, but the committee feels that a general and thorough test should be made and has tried to work out a plan for that purpose.

This plan contemplates the selection of test sections of track and a thorough statement made of the physical characteristics, so that a proper relation can be established.

The test should extend over a period of one year, during which time a special distribution of all labor should be kept on a sheet specially designed to give information not provided by the Interstate Commerce Classification. This test will require special supervision, but the results are deemed worthy of the cost. The results to be obtained by this method will enable certain units to be determined which can be given a relative value, so that an equitable distribution of moneys can be made as between sections of road upon a mathematical basis. In other words, it is a step in the direction of putting this feature of track maintenance upon a scientific basis. The sub-committee has proposed to conduct a series of experiments by its individual members.

The committee recommends the matter to be studied further, and especially recommends that all of the members of the track committee assist in conducting such tests.

CONCLUSIONS.

The committee recommended for adoption and publication in the Manual:

(1) Typical plans of Nos. 8, 11 and 16 crossovers, as representing good practice.

(2) Five diagrams of speeds of trains through curves and level turnouts.

(3) The following table, showing relative speeds through level turnouts, to give the equivalent riding condition to track elevated three inches less than theoretically required:

Turnout		Speed
Frog Number	Length of Switch	Miles per Hour
4	11	9
5	11	12
6	11	13
7	16.5	17
8–10	16.5	20
11–14	22	27
15	33	37
16–24	33	40

The committee recommended receiving as information:

(1) Typical plans of Nos. 8, 11 and 16 double slip crossings.

(2) Cleveland, Cincinnati, Chicago & St. Louis plan of standard No. 8 double-slip switch.

(3) The report on "Speeds of Trains on Curves and Turnouts."

The committee recommended receiving as a progress report, the report on Economics of Track Labor.

The committee recommended recommittal for further study:

(1) Typical plans for double-slip crossings, double crossovers and guard rails.

(2) Relation between worn flanges and worn switch-points.

(3) Economics of Track Labor.

J. B. Jenkins (B. & O.), Chairman; G. J. Ray (D. L. & W.), Vice-Chairman); Geo. H. Bremner, Interstate Commerce Commission, H. M. Church (B. & O), Garrett Davis (C. R. I. & P.), Raffe Emerson (Consulting Engineer), J. M. R. Fairbairn (C. P.), T. H. Hickey (W. N. C.), E. T. Howson (Railway Age Gazette), L. J. F. Hughes (C. R. I & P.), J. R. Leighty (M. P.), Curtiss Millard (C. G. W.), P. C. Newbegin (B & A.), F. B. Oren (I. C.), H. T. Porter (B. & L. E.), E. Raymond (A T. & S. F.), W. G. Raymond (State Univ. of Iowa), L. S. Rose (C. C. C. & St L.), H. R. Safford (G. T.), C. H. Stein (C. R. R. of N. J.), F. S. Stevens (P. & R.), A. H. Stone (K. C. T.), Committee.

Discussion on Track.

J. B. Jenkins, chairman, presented the report.

(Conclusions 1, 2, 3 and 4 were adopted. The conclusions relating to the matters to be received as information were also received.)

Mr. Jenkins: The committee's recommendations for further study are embodied in the last part of the conclusions. The third subject is "Economics of track labor." There is one matter which is very closely related to it. That is "A study of the matter of proper season for various kinds of track

work." The date of the beginning of the fiscal year has a great deal to do with the season at which the track work is done. As the fiscal year begins July first, it is very common to have maintenance expenditures postponed from the spring until the fall, throwing the work into a season of the year when it cannot be done as well and when labor is scarce. The track work is left in a rather uncompleted state when frost comes, and in many cases the track cannot be brought into proper conditions until spring. I do not think it is any exaggeration to say that for every dollar of expenditure postponed in the months of April, May and June that, in order to put the track in the same condition it would have been if that money had been expended at the proper time, it will require about $2.00 to be expended in July, August or September. Further, the committee has undertaken the work of deriving some factors for equating the track mileage, and a few roads have undertaken this to some exent already and the committee thinks it a rather important subject.

C. Dougherty (C. N. O. & T. P.): I desire to suggest to the committee that they should endeavor to arrive at a definite recommendation on the matter of guard rails, if possible, for next year's report, considering the length, the matter of guard rails on tangents as well as on curves, and the relative height of the guard rail to the main track rail.

E. R. Lewis (D. S. S. & A.): In regard to the extension of the duties of the section foremen, I am sure it is not the idea of any member of the committee that the section foreman, with the amount of knowledge that these men now have, and the help which they have at their command, will be expected to take care of signals, bridges and buildings. To my certain knowledge for twenty-five years the offices of railways, from the lowest to the highest, have now and again increased the scope of the section foreman's duties to the detriment of track maintenance, and the same statement holds true to-day.

E. T. Howson (Railway Age Gazette): I would like to emphasize what Chairman Jenkins had to say about a study of the influence of the present fiscal year on the economics of our present track labor. Over 55 per cent. of the total maintenance expenditures of the railroads are for labor, and over 46 per cent. of all maintenance expenditures are for track labor. The greatest deterrant factor to the economical expenditure of this 46 per cent. for track labor today, I think, is the termination of the fiscal year in the center of the natural working season. Under the present financial conditions existing on the roads, many of them find it necessary to limit the expenditures very severely at the first half of the working season up to July 1st. After July 1st the forces are enlarged in an endeavor to do the work which should be done before winter. If the fiscal year could be changed to some other season, perhaps to correspond to the calendar year, these disturbances and interferences would be eliminated and the track work could be conducted through the entire working season, the natural season for this work, which is in the spring and summer. One vice-president told me last week he believed if he could get away from the effects of the fiscal year he could reduce his maintenance expenditures one million dollars, which would be practically ten per cent. of his total maintenance expenditures. The fixing of the present fiscal year is a purely arbitrary date for accounting purposes, and while there would necessarily be some adjustment, after it was changed, I believe the operating and maintenance officers could show such a large saving that the change would be warranted from every point of view.

E. F. Wendt (Mem. Eng. Bd. I. C. C.): I have endeavored to ascertain what reasons led to the selection of June 30 as the closing date of the fiscal year, but, strange to say, have been unable to find any good business reason for it. It is said that is the way the railroads want it. In this case I am sure that the engineers could not have been consulted in regard to this matter; therefore, I wish to most heartily endorse the suggestion of the Track Committee that this is a question for discussion on the part of engineers, and as a result of their study it seems to me that a recommendation could be made which would be valuable.

Hunter McDonald: I hope that the Association will decide to take this matter up, and I fully endorse the idea.

ELECTRICITY

Clearances.

Data has been secured covering overhead clearances on electrified railroads. The committee expects to correct these statements annually for the records of the Association.

A diagram showing typical overhead clearance diagrams for permanent way structures and working conductors has been circulated amongst the members of this sub-committee and their approval has been secured. This diagram conforms generally to the practice indicated on the tabular statement referred to under (a).

In the report of this sub-committee for 1912 it was stated that information was not then sufficient to make recommendations on clearance lines for automatic stops. During the past year a meeting has been held at which representatives of the American Railway Association, American Electric Railway Association and the American Railway Engineering Association were present. After discussion, the joint committee adopted the following resolutions:

"Inasmuch as the present state of development of automatic train stops or speed regulation devices is in an experimental stage, and since no such device has as yet been generally adopted by steam railroads, this joint committee should give no further consideration at this time to the location of such devices on the track structure, and should so report back to their various associations.

"It is recommended to the clearance committees of the various associations that further study be made of the equipment clearance line shown on the third-rail clearance diagram adopted by the American Railway Engineering Association at its meeting of March, 1912, between the point FE and the gage line of the nearest running rail and to the location of the third-rail clearance line between point ET and the gage line of the nearest running rail."

G. W. KITTREDGE,
Chairman Committee on Electricity.

Following this meeting, data on equipment clearance lines of various railroads have been collected. From the present information, it seems that the EE-FE line, indicated on approved diagram "A," of the American Railway Engineering Association, may be extended toward the gage line, and, if further study does not develop serious encroachment, the pace below said extended line would be available for automatic stops or other structures of a similar nature. The sub-committee proposes to continue this study in conjunction with the other associations.

Electrolysis.

"The work assigned is as follows:

"(1) Report on the effect of electrolytic action on metallic structures and the best means of preventing it.

"(2) Continue the investigation of electrolysis and insulation.

"There has been no meeting of the sub-committee on Electrolysis pending the report of a special sub-committee appointed on May 12, for the purpose of representing the committee on Electricity, as members to a national committee on electrolysis, originated by the President of the American Institute of Electrical Engineers. The only meeting of the joint national committee on Electrolysis, thus far held, was convened in New York City on May 27, 1913, at which the following resolution was carried:

"Resolved, That the chairman be authorized to appoint a committee on Scope, Organization and Plan of Work, such committee to include representatives of each of the associations interested, and that no further attempt at work be made by the joint committee until the committee on Scope, Organization and Plan of Work can tender a report to the

joint committee, outlining the scope of its work and suggesting a plan of procedure.

"The useful work of the joint national committee on Electrolysis is therefore at the present time held up pending appointment of delegates from the American Gas Institute, the American Water Works Association and the National Gas Association of America."

George W. Kittredge (N. Y. C. & H. R.), Chairman; J. B. Austin, Jr. (L. I.), Vice-Chairman; D. J. Brumley (I. C.), R. D. Coombs (Consulting Engineer), A. O. Cunningham (Wabash), Walt Dennis (C. R. I. & P.), L. C. Fritch (C. G. W.), George Gibbs (P. R. R.), G. A. Harwood (N. Y. C. & H. R.), E. B. Katte (N. Y. C. & H. R.), C. E. Lindsay (N. Y. C. & H. R.), W. S. Murray (N. Y. N. H. & H), J. A. Peabody (C. & N. W.), Frank Rhea (Interstate Commerce Commission), J. W. Reid (C. & A.), A. F. Robinson (A. T. & S. F.), J. R. Savage (L. I.), A. G. Shaver (C. R. I. & P.), Martin Schreiber (Public Service Railroad), W. I. Trench (B. & O.), H. U. Wallace (Nov. Col. Power Co.), Committee.

Discussion on Electricity.

G. A. Harwood, vice-chairman, presented the report of the committee.

E. B. Katte (N. Y. C. Lines): Since the report was printed two meetings of the Joint National Committee on Electrolysis have been held in New York, and two associations, the American Gas Institute and the Natural Gas Association of America, which had not previously sent delegates to our meetings, have not appointed members and are represented on the joint committee. The American Water Works Association was the last of the big bodies interested in electrolysis to join the work. The National Bureau of Standards has appointed Dr. E. B. Rosa, the chief physicist of the Bureau at Washington, who has consented to serve on the committee and is acting as its secretary.

(Mr. Katte then outlined the work of this Joint Committee.)

(Recommendations 1 and 2 were approved.)

The President: In recommendation 3 the committee requests the convention to state what subjects in addition to those now being considered should be taken under consideration.

E. B. Temple: I suggest that the committee look into the matter of clearances, as to where trainmen can remain on top of cars and where they cannot.

WOOD PRESERVATION

The Board of Direction assigned the following subjects:

(1) Continue investigations of the merits as a preservative of oil from water-gas and the use of refined coal tar in creosote oil.

(2) Continue the compilation of available information from Service Tests.

(3) Continue the investigation of the proper grouping of the different timbers for antiseptic treatment, conferring with Committee on Grading of Lumber.

(a) Merits as a Preservative of Oil from Water-Gas Tar. absorption of creosote oil.

OIL FROM WATER-GAS AND COAL-TAR IN CREOSOTE OIL.

(a) *Merits as a Preservative of Oil from Water-Gas Tar.* The large railroad mentioned in last year's report as contemplating the use of a mixture of coal-tar creosote and oil from water-gas tar did not use this mixture, because the cost of the water-gas oil was too high. The Public Service Railroad Company has in use 25,000 ties treated in 1911, 75,000 treated in 1912 and 60,000 treated in 1913, with 10 lbs. per cu. ft. of oil from water gas. Arch Street, Philadelphia, has been paved with wood blocks treated with this oil, but too recently to get results. Some heavily-treated paving blocks at Baltimore have rotted after seven years' use, and the oil after extraction analyzed like oil from water-gas tar.

The Forest Service has compared a water-gas tar, specific gravity 1.058 at 60 Centigrade, and a coal-tar creosote, specific gravity 1.048 at 60 deg. C., with the following results: "The water-gas product seems to be absorbed as readily as the creosote, though its diffusion through the wood was very much poorer than creosote. In the volatility test the specimens were submitted to a constant temperature in dry air for 90 days. The specimens treated with water-gas tar lost 18 per cent., while the creosoted specimens lost 32 per cent. The inflammability of the wood treated with the water-gas tar product was about the same as creosoted specimens. In the toxicity tests, agar solutions of water-gas product up to three per cent. allowed a strong growth of fungus, while 0.2 per cent. agar solutions of coal-tar creosote allowed a slight growth only, and 0.4 per cent. allowed no growth at all. Corrosive action of both substances on steel is negligible, and neither can be used in wood whose surfaces are to be painted."

Partial tests of the Forest Service on mine timbers show that loblolly pine treated with 10 lbs. per cu. ft. of oil from water-gas tar, specific gravity 1.064 at 50 deg. C., is economical. The life of these timbers necessary to be economical is 2¾ years, while the treated material has already lasted three years.

On account of the present lack of definite data as to its efficiency, its rising price and the uncertainty of its preservative value, it is thought not advisable at this time to recommend the use of oil from water-gas tar as a wood-preservative.

The Use of Refined Coal Tar in Creosote Oil.

The committee has given careful consideration to the question of adding coal tar to creosote oil. The information collected clearly establishes the fact that a considerable amount of timber is being treated with a coal-tar creosote mixture;

EARL STIMSON,
Chairman Committee on Wood Preservation.

also, that present conditions governing the supply and cost of creosote oil indicate an increased use of the mixture.

Although the addition of coal tar to creosote is sufficiently extensive to require recognition, it is not a clearly defined practice as regards technical application. At the plants where the mixture is used, it is applied under conditions which vary from open specifications and a full understanding, to surreptitious use where not specified or allowed.

The committee's investigations indicate that up to date the results obtained from the use of the coal-tar creosote mixture are not sufficiently definite, as to character of treatment and preservative qualities, to permit of specific recommendations as to its merits as a preservative. It is, however, the opinion of the committee that coal tar should not be added to high-grade creosote, and it therefore submits the following recommendation for insertion in the Manual:

Conclusion 1: The committee recommends that wherever possible only Grade 1 coal tar creosote should be used, and that under no circumstances should coal tar be added to creosote of this grade.

While making only one definite recommendation, because of lack of information on which to base additional conclusions, the committee realizes that on account of the inadequate supply of grade 1 creosote, and because of individual conditions or opinions, various roads may add coal tar to the creosote used. The committee, therefore, advises that in such cases the following precautions be taken, it being clearly understood that these are appended without making any recommendations as to the advisability of the coal-tar addition to creosote:

Conclusion 2: Where it is thought advisable by any company to use coal tar, in mixture with the lower grades of creosote, i. e., grades 2 and 3 of the American Railway Engineering Association, the committee recommends that the following precautions be followed, and they are submitted for adoption and insertion in the Manual:

(1) That there be a distinct understanding between all concerned that a mixture is specified and used.

(2) That the coal tar be added to the creosote under the direct supervision of the railway company, and preferably at the plant.

(3) That under no circumstances should the coal tar added constitute more than 20 per cent. of the mixture.

(4) That the coal tar and creosote be thoroughly mixed at a temperature of approximately 180 deg. F. before being applied to the timber, and that the mixing be done in tanks other than the regular working tanks, and that the tanks containing the mixture shall be heated and agitated thoroughly each time before any oil is transferred to the working tanks.

(5) That only low-carbon coal tar be used, the amount of free carbon not to exceed 5 per cent.

(6) That in treating with the mixture the temperature of the solution in the cylinder be not less than 180 deg. F.

GROUPING OF TIMBERS FOR ANTISEPTIC TREATMENT.

There is so much variation in the absorptive powers of the different kinds of timber, the same kind of timber growing in different localities, and even timber from different parts of the same tree, that any definite and detailed rules for grouping so as to obtain exact results are impossible. The committee, however, has promises that some experiments will be made along this line during the coming year, from which it may be able to formulate a few general rules regarding the absorptive power of the different kinds of timber and also the absorptive power of the same kinds of timber with different percentages of sap and heartwood.

METHODS OF ACCURATELY DETERMINING THE ABSORPTION OF CREOSOTE OIL.

A brief discussion of the present practice in determining the absorption of creosote oil in the treatment of timber is submitted as a basis for the consideration of new and improved methods. Three systems are in general use for determining the absorption of preservatives, as follows:

(1) By gage readings of tanks, with temperature corrections.

(2) By weighing the oil in the working tanks before and after treatment of charges in the cylinder.

(3) By weighing the cylinder charges before and after treatment.

A description of these methods is given below:

(1) Measurements by Gage Readings of Tanks, with Temperature Corrections.

This is the method in most general use at treating plants, and has two forms of application, as follows:

(a) The simplest form of gage reading is to measure the level of the oil from some fixed point on the top of the tank with a steel tape and plumb-bob. Common chalk rubbed on the plumb-bob indicates to what depth it has been lowered in the liquid.

(b) An improved and commonly-used apparatus for gage readings consists of a float which is connected by a wire or chain over a system of pulleys, to an indicator which moves up and down a graduated gage-board as the height of the oil in the tank varies, the gage-board being so placed as to be easily read by the operator. Instead of this gage-board the wire from the float is sometimes connected with the drum of a recording gage. A system of properly designed gears, operated by this drum, causes a movement of the indicator hands over a dial graduated into feet and fractions thereof as the level of the oil in the tank changes. A counterweight is attached to the drum to offset the friction in the gears and pulleys.

Some of the causes of errors peculiar to float and gage readings are mentioned in Bulletin 126, Forest Products Laboratory Series, United States Department of Agriculture, as follows:

Change in position of float with change in its volume due to temperature.

Change in position of float with change in specific gravity of the oils.

Variation in length of gage wire or chain with change of temperature.

Change in volume of measuring tank with change in temperature.

Position of indicator as affected by resistance in the gage and difference in tension in the gage wire.

Inertia of the gage and friction of the pulleys.

The possible lack of uniformity in the temperature of the oil in the measuring tank at any given time.

The temperature of the oil must be taken and corrections of the volume made for temperature change. The temperature of the oil in the tank at time the gage readings are taken is determined either by:

(1) A long-stemmed thermometer, placed at the side of the tank a sufficient distance above the heating coils, so that its reading may not be affected; or

(2) Taking the temperature of a sample of oil representing an average of the entire contents of the tank, which may be obtained with an "oil thief," with an ordinary thermometer.

(2) Measurements by Weighing the Oil in the Working Tanks Before and After Treatment of Charges in Cylinders.

This heading may be divided into two classes:

(a) As determined by direct weighing.

(b) As determined indirectly by means of a mercury gage.

(a) In the first method the working tanks are mounted on scales with scale beam ordinarily graduated to 20 lbs. A type-registering attachment permits the recording of the weight.

Measurements of absorption, as determined by weight of oil taken from the working tank, makes it unnecessary to take temperature variation into consideration, thereby lessening the tendency for inaccuracy from that course. It requires frequent determination of the specific gravity of the oil in case the absorption of the treated material is desired in gallons, or by volume.

(b) Mercury gages have been installed in several creosoting plants. Their principle consists of counterbalancing a free column of oil in the working tank with a mercury column. In order to permit close reading of the mercury thread, the scale is usually set at an angle, to permit a larger scale and consequently closer reading.

(3) Determination of Absorption by Weighing the Cylinder Charge Before and After Treatment.

The use of track scales for the determination of the absorption of creosote oil in timber is very common. As a check of the oil as measured or weighed in the working tanks, it is very desirable and should be inaugurated as far as possible. It is only, however, where there is no appreciable loss of moisture and sap from timber during treatment that this method can be used with accuracy. The volatility of creosote at the temperature at which treatment is ordinarily conducted is somewhat high, which necessitates the immediate weighing of the charge as soon as it is taken out of the cylinder in order to minimize the error in determining the absorption in this manner, because of the evaporation of the oil from the treated timber.

Discussion and Conclusions.

Absorption when determined either by gage readings or weights of the creosote in the working tank before and after treatment makes it necessary that either all oil in the pipe line and subsidiary tanks from working tanks to cylinder is returned to the working tank before readings are taken, or some method be devised for accurately determining such oil in pipe lines and subsidiary tanks and allowances made accordingly.

In case water is introduced in the creosote during the treating process, which is sometimes the case when timber is artificially seasoned in the cylinder, a determination of the water content of the oil in the working tanks before and after treatment must be made and the gage readings or weighings changed correspondingly.

Of the three systems practiced for determining creosote absorption, the weighing of the oil in the working tanks before and after treatment is considered best, although either of the other systems, when properly checked, is practicable.

Without attempting to make final recommendations at the present time, attention is called to the need of a more logical basis for absorption determination, and certain general modifications in practice are recommended. The term "accurate" under the present practice is only relative, since errors which make the determinations only approximate result from both the basic unit of absorption and from inaccuracies in readings and equipment.

The usual practice in treating specifications call for a given number of pounds per cubic foot of timber, or a stated number of gallons per tie. In both cases the essential factor of penetration is ignored. What is wanted is maximum penetrations, which with most woods means complete penetration of the sapwood and of the heart to the extent possible with the kind and condition of the timber treated. The exceptions which occur—as in red oak, which gives heartwood absorption, and red fir, which resists even sap penetration—do not affect the general rule.

The fallacy of the present unit is evidenced by the fact that a specific absorption may be given in the outer inch of a two-inch ring of sapwood, which would not be good treatment. On the other hand, a 10-pound treatment, for example, may be specified for a wood which is 60 per cent heart, resulting in a 25-lb. absorption in the treatable portion, with the consequent waste and expense. Moreover, oil is bought by the gallon at a specified temperature and injected into timber on a pounds-per-cubic-foot basis, thus complicating check of quantities and inventory.

While the difficulties of specifying the proper amount of oil for full penetration of the treatable portion of timber is realized, particularly at commercial plants, where costs must be definitely estimated in advance, it is believed that at railroad plants the best treatment for each particular class or kind of timber should be given and the costs based on the amount of oil used. If the various departments concerned feel it necessary, a maximum could be named, and, if insufficient, it would simply result in lighter treatment in the treatable portions of the wood. In most cases it is believed this plan would effect a saving: Master carpenters, for example, are in the habit of specifying 12 lbs. for structural timber. When long-leaf pine dimension timbers are used, this often means 20 lbs. or more per cubic foot in the parts of the stick which absorb oil, which is more than is needed to prevent decay under normal conditions.

Conclusion 3: At railroad plants the absorption be based on the treatment which will give the most complete penetration of the sapwood and as much of the heart as possible for the particular species or charge; payment to be based on the amount of oil used, plus operating and other charges.

Conclusion 4: Where railroads have their work done by contract, it is recommended that gallons be specified for ties, posts, cross-arms and other material of uniform size, and pounds per cubic foot for other material; the same requirements as to sap and heart penetration to be applied as in the above.

It is also recommended that the committee pursue investigations next year relative to a more definite and satisfactory basis for determining creosote absorption, and also of improved mechanical means of checking the absorption.

OUTLINE OF WORK FOR 1914.

The committee recommended:

(1) Continue investigation of the use of coal tar in creosote oil.

(2) Continue the compilation of available information from service tests, supplementing this with reports of inspections to be made by members of the committee, of those sections of test track that have been in service long enough to give results.

(3) Investigate the subject, "Water in Creosote."

(4) Prepare specifications for timber to be treated.

(5) Report on a more definite and satisfactory basis for determining creosote absorption and improved mechanical means of checking the absorption.

Earl Stimson (B. & O.), chairman; E. H. Bowser (I. C.), vice-chairman; H. B. Dick (B. & O. S. W.), C. F. Ford (C. R. I. & P.), Dr. W. K. Hatt (Purdue Univ.), V. K. Hendricks (St. L. & S. F.), Jos. O. Osgood (C. R. R. of N. J.), George E. Rex (A. T. & S. F.), E. A. Sterling (Consulting Engr.), C. M. Taylor (P. & P.), Dr. H. von Schrenk (Consulting Engr.), T. G. Townsend, (Soo), Committee.

Discussion on Wood Preservation.

(Earl Stimson, chairman, presented the report and outlined the work of the committee. S. R. Church, of the Barrett Manufacturing Company, presented an outline of tests that had been made, comparing the use of creosote oil and a mixture.)

Mr. Stimson: I move that Conclusion 1 be adopted by the association and inserted in the Manual.

J. L. Campbell (E. P. S. W.): As a practical proposition, in case of the scarcity of creosote, there is a question in my mind about the advisability of adopting that conclusion as it stands. It would seem to me that if it were necessary to adulterate for any reason—and the principal reason that a good many people do it is that it is difficult to get creosote—that we could better afford to adulterate first-class creosote than we could afford to adulterate an inferior grade.

Dr. H. von Schrenck (St. L. & S. F.): We have taken a rather strong stand with reference to the term adulteration as applied to the addition of coal tar to the creosote oil. In view of the fact that the coal tar is the matrix or mother liquor from which coal oil is distilled, the addition appears to us to be in the nature of an addition of a similar product, rather than the sense in which that word ordinarily is used. It is the creosote oil which has given the longest length of life records, both in this country and abroad, and we feel that any addition to it, while it might to a certain extent increase the permanency of such oil in the wood, would be in a sense changing its very character and we did not feel that we were warranted in recommending the addition of coal tar, which after all being added to No. 2 or No. 3 oil, was making the best of the situation being forced on us, due to the lack of No. 1 oil.

Mr. Camp: I fear that the adoption of these conclusions may be misleading. They may be used to show this association does recommend adulterating creosote. I think it is letting down the bars to use an inferior grade of antiseptic which will go under the name creosote. Creosote is the best material to be used in treating ties. I am afraid if a method of treating ties by an adulterated method is approved, that may be taken as approval of the method.

Mr. Stimson: The committee does not recommend, but we recognize a prevalent practice. The question is whether we want to stand out for a practice that is obsolete and ignored, or whether we want to frame our recommendations to meet working conditions.

Dr. von Schrenck: Some years ago this committee brought in three specifications for creosote oil, No. 1, No. 2 and No. 3, and at that time Mr. Fritch said: "You bring in three specifications. You give us nothing to indicate when we shall use No. 1, No. 2 and No. 3." At the present time we say: "When you can buy No. 1 oil use it, and don't add any coal tar to it. When you cannot get No. 1, if you decide to use No. 2 or No. 3, use it, either in larger quantities, according to our recommendation two or three years ago, or if you decide you are going to put coal tar into No. 2 or No. 3, be careful that you follow some of these precautions."

Mr. Stimson: The committee wishes it distinctly understood that it does not recommend the addition of coal tar to the No. 1 grade. We want to preserve the No. 1 grade as the high standard. We do not recommend changing our standard in this manner, and we wish the recommendation to go before the convention as it stands.

(Conclusion No. 1 was then adopted.)

Mr. Stimson: We want to strike out the words "and poorer" after "American Railway Association," in Conclusion 2.

(Conclusion 2 was also adopted.)

(Conclusions 3 and 4 were then read and approved.)

GRADING OF LUMBER

The special committee on Rules for the Grading and Inspection of Maintenance of Way Lumber has, during the past year, been engaged in trying to formulate additional grading rules

H. VON SCHRENK,
Chairman Committee on Grading of Lumber.

for such classes of lumber as have not yet been standardized. The work has unfortunately been retarded, owing to the fact that many of the rules for such timbers, particularly hemlock and western timbers, are still in a process of development. It was therefore not thought advisable to force the formulation of such rules by the committee, but to await

their definite adoption by the associations manufacturing such classes of lumber. It is anticipated that the rules for hemlock and some of the Pacific Coast timbers will be in shape for presentation at the next convention.

The committee reports progress in the adoption of the rules already in the Manual. A recent communication is received from one of the largest associations manufacturing lumber, advising that the changes made in the rules as adopted by this Association last year are very slight. The committee would respectfully urge all members to use these rules in the purchase of maintenance of way lumber. They may not always fit the requirements, nor will they always quite agree with the commercial grades of manufactured lumber, because the latter changes from year to year. The changes, however, do not materially affect the quality as described in the grades. A more universal use of the lumber grades as already adopted in the Manual will tend towards the elimination of odd sizes and grades.

Dr. H. von Schrenk, chairman (Cons. Engr.); B. A. Wood, vice-chairman (M. & O.); W. McC. Bond (B. & O.), D. Fairchild (N. P.), R. Koehler (O. W. R. & N.), A. J. Neafie (D. L. & W.), W. H. Norris (Me. C.), R. C. Sattley (C. R. I. & P.), J. J. Taylor (K. C. S.), Committee.

WATER SERVICE

WATER TREATMENT AND RESULT OF STUDY BEING MADE OF WATER SOFTENERS FROM AN OPERATING STANDPOINT.

The report on this subject has been divided into three sub-headings:

(1) Economy of water treatment.

(2) Present situation as to water treatment on railroads.

(3) General rules for the installation and operation of water softeners, and the use of treated water, based on a study of water softeners from an operating standpoint.

Economy of Water Softeners.

Much information has been published from time to time, showing clearly the benefits to be derived from the treatment

A. F. DORLEY,
Chairman Committee on Water Service.

of water for hardness, but on the whole this has been of a descriptive character, containing insufficient numerical data to show, mathematically, the relation between the character of the water and the economy of treatment. The section of the Manual devoted to water service contains a formula for determining the justifiability of treatment. The section fact a mathematical expression of the principles of water treatment. The difficulty, however, is in assigning numerical values to the various terms. The principal reasons for this are as follows:

(1) Many of the benefits are of such an intangible nature as to be very difficult of mathematical expression.

(2) The necessary subdivision of cost of locomotive, operation and maintenance is not generally obtained.

(3) Presence of other variables, as in making a comparison between two divisions of a road, one with softeners and one without, or on a given division, before and after installation of softeners. In the one case, we encounter variation in physical conditions, traffic, personnel; in the other changes in equipment and policy, while both are affected by transfer of power from division to division.

Current Practice as to Water Treatment.

The present situation as to the treatment of water on railroads presents a rather complex outlook. While softening plants are in use on nearly all roads, and some lines have installed a sufficient number to eliminate bad water at practically all important water stations, it is a fact that a large number of roads are resorting to other means, in efforts to eliminate the effects of bad water. These are enumerated as follows:

(1) The use of soda ash (sodium carbonate) directly in locomotive tanks.

(2) The use of some proprietary anti-scaling compound, with or without an anti-foaming ingredient, either in the locomotive tank, or directly in the boiler.

(3) The treatment of water with soda ash only, in the road tanks, generally with provision, through a float outlet and a sludge valve, for the removal of a portion of the sludge. The "soda ash plants" permit of an accuracy of proportioning impossible with methods 1 or 2. They are used in some instances as auxiliaries to complete softening plants, to give a partial treatment to water at the less important stations where the installation of a softening plant was not considered justifiable.

The failure of the roads to go more generally into the use of complete water softeners is accounted for by the fact that the installation of water softeners involves a considerable initial outlay as compared with the use of compounds, which require no plant at all. It is also due to the fact that on one or two roads, due to good organization and intelligent supervision, excellent success has been attained with the use of soda ash plants, which involve little investment for plants as compared to complete treatment plants.

Investigation of the failure or abandonment of such softening plants, as have been brought to the notice of the committee have been found to be the result of faulty design, supervision or operation, rather than any inherent fault in the principle of water softening. The general rules for installation and operation given hereafter are in part the result of such investigation.

General Rules for Installation and Operation of Water Softeners and Use of Treated Water Based on Study of Water Softeners from an Operating Standpoint.

Design and Installation.—(1) The plant must be of adequate capacity. It is necessary to anticipate possible increases in consumption of water at the station considered. This may result from an increase in the volume of traffic, a reduction in the number of stops for water, due to the increase in size of engine tanks, or to a preference for treated water over that at adjoining stations not treated. The prospective plant must be carefully investigated to ascertain if the proportions of all parts are such as to insure the rated capacity. It is not safe to accept a plant requiring a reduction in the time for treatment because of special appliances purported to accelerate the process.

(2) The installation of softening plants must follow a systematic plan. Greater success is generally obtained by completing the installation on one division first, rather than installing plants at individual points of especially bad water. A softening plant is not completely successful as long as engines served have badly encrusted boilers, and desired improvements in this respect cannot be fully obtained when engines take water from other stations, which is high in incrusting matter. This condition, of course, would not obtain in the case of a plant at the single intermediate water station for passenger engines, where the water at the terminals was of good quality, or in a plant at a terminal serving a great many switching or transfer engines that receive water from no other source.

(3) The mechanical features of treating plant must be so simple as not to require expert attendance. Where proportioning is automatic, it is essential that the machine is not easily thrown out of adjustment.

(4) Feasibility of treatment of a given water should be carefully investigated. This applies especially to waters containing large proportions of incrusting sulphates or sulphates in combination with quantities of alkali salts. Treatment of such water by the Porter-Clark process may result in water containing such high proportions of foaming solids as to be entirely unusable.

Operation, Maintenance and Supervision.—(1) Adequate supervision is necessary to successful operation of a softening plant. Such supervision must be exercised at least in

part by a chemist, or an engineer having adequate knowledge of water treatment. A tendency on the part of operating and mechanical officials to underestimate the importance of treating plants has frequently been evidenced, emphasizing the necessity for supervision on the part of someone who has the interests of the plant at heart.

(2) Provision should be made for frequent analysis of both the treated and raw water. This is necessary, principally as a check on the treatment, and also to some extent on account of changes in the condition of the raw water. This is of more importance with water from streams or surface reservoirs; but even with wells, changes occur occasionally, due to entrance of surface water, or perhaps to failure of supply from one of the several water-bearing strata.

In order that the analyses shall be effective, they must be made under the supervision of a competent chemist. Simple tests with soap and acid solutions which are of sufficient accuracy to handle ordinary operating results, should be made at least once a week by the chemist for check purposes.

Where creek or other water subject to sudden changes is softened, a simple testing outfit, accompanied by specific instructions and chart for each individual water, should be provided for the plant operator, who with a little practice and a weekly check by the chemist will become sufficiently proficient to make formula changes to meet the variations in character of water.

(3) Proper mechanical operation and maintenance of the treating plants must be provided for through adequate supervision on the part of a supervisor of water service, bridges and buildings, or equivalent officer. Where the division organization is in use, a check on such supervision must be maintained by an engineer directly responsible for the water treatment.

(4) Where the plant is inadequate in size, arrangements should be made to use raw water to such an amount as to permit of proper treatment of all water that passes through the softener.

Use of Treated Water.

One of the objections against water softeners is the foaming of boiler water following treatment. There is good reason to believe that the importance of this objection is occasionally overestimated. This is evidenced by the fact that natural alkali waters are being used successfully on some western roads, which contain many times the amount of foaming solids which have caused criticism of treated waters. Foaming is of much more immediate concern to the enginemen than the presence of scale in the boiler. It serves as a good excuse for delays.

Anti-foaming compounds are, of course, in general use to overcome this condition, but experiments go to show that with a minimum of suspended matter the content of alkali salts can be carried to a considerable degree of concentration without trouble from foaming. The primary measure, therefore, should be to obtain clean boilers and clean water so far as practicable. There are, of course, conditions where the concentration of foaming solids is so great that the required amount of blowing off would be both impracticable and uneconomical, and it is necessary to resort to anti-foaming compounds.

Example Illustrating a Method for Calculation of the Economies Resulting from the Installation of Water Softeners.

In estimating the beneficial effects of water softening, the following were considered:

Loss of fuel due to the insulating effect of scale on flues and other heating surfaces.

Renewal of flues account of scale accumulation and injury to flue ends from repeated caulking.

Caulking of flues and other enginehouse boiler repairs.

Loss of engine time during periods of boiler and firebox repairs.

No consideration was given to the indeterminate transportation losses and interruptions to traffic due to engine failures resulting from leaky flues; nor to the saving in engine time and enginhouse labor for washing out boilers brought about by the removal of the suspended matter in natural waters by treatment.

The percentages of fuel loss used below were determined by a series of tests made at the University of Illinois. The thickness of scale with the water of 20 grains average hardness was taken at ¼-in. at the time of flue renewal, and 1/16-in. with the water of 7 grains average hardness. The price of coal was taken at $1.45 per ton, with 12 cents additional for handling, and 36 cents for hauling, or a total of $1.93 per ton on the tender. The life of flues, the cost of boiler repairs and the loss of engine time used in the estimate are the average figures obtained from the existing conditions on various railroads in the middle West.

The cost of $234 for the removal of flues represents the average of $125 for labor for each removal for cleaning, and cost of 13½ cents per foot of flues, less scrap value for each sixth removal.

The $13 value per engine day represents 10 per cent. for depreciation and interest on a valuation of $16,000 per engine, and 7 cents per engine mile to cover maintenance.

Following are comparative estimated operating figures of a 106-ton engine, with a mileage of 45,000 miles per year, a coal consumption of 4,500 tons and water consumption of 7,500,000 gallons:

20-Grain Water.

15.6 per cent. loss of fuel due to ⅛-in. average scale....	$1,354
1⅓ set of flues at $234........	312
Roundhouse flue repairs........	252
13 days' loss of engine time at $13........	169
	$2,087

7-Grain Water.

7.82 per cent. loss of fuel due to 1/32-in. average scale..	$ 677
4/5 set of flues at $234........	187
Roundhouse flue repairs........	142
8 days' loss of engine time at $13........	104
	$1,110

Saving per locomotive per year, $977.00.

As the difference of 13 grains of hardness in 7,500,000 gallons of water represents 13,929 lbs. of incrusting solids, it is concluded that the saving of $977 per locomotive represents 7 cents per pound of excess scaling matter entering the boiler, or 13 cents per 1,000 gallons of water treated.

To obtain the net saving we must subtract from the above the cost of treatment, and the cost of water wasted in blowing off to overcome foaming.

Cost of treatment should be made up of interest and depreciation of the plant, cost of chemicals and cost of operation, maintenance and superintendence.

The loss due to blowing off has been thoroughly discussed previously in the report of the committee in 1907.

In making a comparison between the results above given and those in the first report shown below, it is to be noted that the former is based on the removal of 13 grains of incrustants per gallon, or 1.85 lbs. per 1,000 gallons, while the latter is based on the actual removal of an average of 23 grains per gallon, or 3.3 lbs. per 1,000 gallons.

A Report Showing the Economies Resulting from the Installation of Water Softeners on a Large Railroad in the Middle West.

The installation of water softening plants on this system began in 1905, and to date a total of 45 plants have been provided and are in operation. The total investment is approximately $136,000. The average amount of water treated for locomotive and stationary boiler purposes per year, by reducing the hardness to a point at which it will form practically no scale, is 1,692 million gallons. The total average amount of scale-forming solids removed from the water by treatment per year is 5,537,000 lbs., or an average of 3.3 lbs. per 1,000 gallons. In calculating the benefits of water softening in the figures given below, the following losses resulting from the use of bad boiler waters were considered:

Frequent renewal of flues and other parts of boilers account of scale accumulation; also injury to flue ends from repeated caulking.

Labor caulking flues and other enginehouse boiler repairs.

Loss of engine time during periods of boiler and firebox repairs.

Loss of fuel due to the insulating effect of scale on flues and other heating surfaces.

The total loss per year that would result from the above causes in the absence of water treatment on this system is calculated from the best conservative figures available from the experience on this and other roads to be about $166,771, or 9.8 cents per 1,000 gallons treated, or 3 cents per pound of incrusting solids removed.

The total annual cost of treatment including interest, depreciation, maintenance, chemicals, supervision, etc., is $62,861, or 3.7 cents per 1,000 gallons treated, or 1.1 cents per pound of incrusting solids removed. The net saving is therefore about $103,910, or 6.1 cents per 1,000 gallons treated,

A COMPARISON AS TO BOILER REPAIRS ON THREE DIVISIONS OF A WESTERN RAILROAD, SHOWING EFFECT OF WATER TREATMENT

Divisions A and B are equipped for Water Treatment, Division C was without Treatment. The cost of Machinery Repairs is not included in the Statement. The Loss of Time includes that due only to Work on the Boilers.

	Div. A	Div. B	Div. C	Loss Div. C, Compared with	
				Div. A	Div. B
RUNNING REPAIR DATA BOILER WORK, ALL ENGINES.					
Average Engines in Service per month	112	80	61		
Cost of Boiler Work—Running Repairs	$15328.50	$19162.36	$25066.25		
Average per month	1277.38	1596.96	2688.85		
Cost per Engine in Service per month	11.40	19.96	34.24		
Cost based on No. Engines on Div. C	695.40	1217 56	2088.56	$1393.45	$871.29
CLASSIFIED REPAIR DATA BOILER WORK. (New 900 and 800 Passgr. and 1900 and 2000 cls. Frt. on Div. A. & Div. C., and 800 and 1700 on Div. B.)					
Number Engines in Comparison	30	13	39		
Total Cost Boiler Work (Period Averaging 16 months)	$9350.02	$3638.49	$26952.92		
Cost per Engine per Month Service	19.48	17.49	43.19		
Cost Based on No. Engines on Div. C	1188.28	1066.89	2634.59	$1446.31	$1567.70
LOSS OF SERVICE ACCOUNT ENGINES IN SHOP.					
Engines in Comparison	30	13	39		
Number of Shoppings	63	37	114		
Total Days Out of Service, Based on Avg. Figures	1428	712	2184		
Per Month Figures include 16 Months	89	45	137		
Per Engine per Month	2.9	3.4	3.5		
At $15.00 per Day, One Engine One Month	$ 43.50	$ 51.00	$ 52.50		
Cost Based on No. Engines on Div. C	2653.50	3111.00	3202.50	$ 549.00	$ 91.50
Total Per Month				$ 3388.76	$ 2530.49
Total Per Year				40665.12	30365.88
Total One Engine Per Month				55 55	41.49
Total One Engine Per Year				666 64	497.80

Besides this to be considered is life of fire-box. This is about ten years in good water, about three on C Division, Cost of applying a fire box about $1,000.00. The difference on 55 road engines on Division C would amount to $1,000.00 per month.

or 1.9 cents per pound of incrusting solids removed. This net saving reduced to a "per engine" saving on the basis of the total number of 106-ton engines required to evaporate the amount of water treated gives an average annual saving per engine of $458. This average figure compares favorably with the saving per engine reported to result from water treatment on a neighboring line, which is $439.

In arriving at the above figures of saving, no consideration was given to the following benefits of water treatment, which, though more or less intermediate, are generally recognized to be large:

Improvement in road performance of locomotives by reducing failures and interruptions to traffic due to leaky flues.

Saving in engine time and enginehouse labor for washing out boilers brought about by removal of the suspended matters in many natural waters by treatment.

The reduction in number of locomotives required for a given traffic due to improved road performance.

These latter benefits will be found to offset many times the foaming troubles that are always present in the alkali districts of the Western lines, and which are aggravated by treatment.

A. F. Dorley (M. P.), chairman; J. L. Campbell (E. P. & S. W.), vice-chairman; C. C. Cook (B. & O.), R. H. Gaines (K. C. S.), W. S. Lacher (C. M. & St. P.), E. G. Lane (B. & O.), A. Mordecai (Consulting Engineer), W. A. Parker (S. J. & G. I.), W. L. Rohbock (W. & L. E.), Chas. E. Thomas, Committee.

Discussion on Water Service.

(A. F. Dorley, chairman, presented the report.)

(Subject No. 2 was received as information.)

J. L. Campbell (vice chairman): I want to refer to paragraph 1 under "Economy of Water Softeners." As a result of the expenditure of a very large sum of money on the road that I represent, a very bad supply of water on one division of the road was replaced with a supply of very good water, and one of the most marked benefits we derived from that was what may be described as a great improvement in the esprit de corps in the entire organization.

BUILDINGS

The following subjects were assigned:

(1) Present principles covering design of inbound and outbound freight houses.

(2) Report on the advantages and disadvantages of the various designs of freight house and shop floors.

(3) Report on methods of heating, lighting and sanitary provisions for medium sized stations.

The following summary of the last report on Roofing is to replace the present conclusions regarding that subject in the Manual.

ROOFING.

In selecting a roofing there should be considered:

(1) Chance of leaks, due to character of construction.

(2) Probable life, including chance of damage by the elements and by wear from other causes.

(3) Fire-resisting value.

(4) Cost of maintenance.

(5) First cost.

MAURICE COBURN,
Chairman Committee on Buildings.

The important materials may be classified as follows:

Bituminous substances, applied with felts made of rags, asbestos or jute.

Clay and cement products and slate.

Metals.

They are laid in two general types: That for a flat roof, cemented together, as a coal-tar pitch and gravel roof or as an ordinary tin roof; and that for a steep roof, laid shingle-fashion.

Bituminous Materials.

The common bituminous materials are: coal-tar pitch (the heavier distillates of bituminous coal); various asphalts (bituminous found naturally in the solid state); various petroleum products, and various animal and vegetable residues. Their peculiar value lies in the fact that they are practically insoluble in water, and that they are elastic, adhesive, and comparatively stable.

Coal-tar pitch is easily affected by heat and cold, is not acted upon at all by water, is easily worked, and, if properly protected, is very stable. It should ordinarily be used as it comes from the still "straight run," of a consistency suitable to the climate and to proper application.

Water-gas tar pitch, a by-product in the manufacture of water gas, which is enriched by gas from petroleum oils, resembles coal tar. It is inferior to coal-tar pitch for roofing purposes, and materials made from it should only be accepted in the low-priced products. It has more value as a saturant of felts than as a coating.

The asphalts are unsuitable for use in their natural state. They are ordinarily fluxed with products of petroleum. The petroleums found in this country vary considerably, and grade roughly in quality, according to location from east to west. The California oils, with their asphaltic base, furnish materials especially valuable for roofing.

The blowing of air through a heated still of certain petroleum products produces "blown oils," which, while somewhat lacking in adhesive properties, are not easily susceptible to atmospheric changes and are valuable especially for roofing coatings.

A single asphalt fluxed with a single oil is for most purposes a crude and unsatisfactory material. To secure the best results for any desired purpose, several oil and asphaltic substances must ordinarily be compounded. This requires skill and experience. Those properly made are for certain conditions invaluable, particularly for ready roofing, for which tar products are not suited.

The asphalt and petroleum products are not so readily affected by heat and cold as is coal-tar pitch, and lesser amounts of them are necessary to get good results. They are more expensive, require more skill in handling, and, when protected, some at least are to some extent liable to lose their life by drying out of the oil fluxes. Unprotected, they do much better than does coal tar.

Felts.

The bituminous substances are used with felts whose qualities considerably affect the roofing. The ordinary felt is made of rags, mainly cotton. "Wool Felt," is a misnomer. Asbestos felts, as compared with the rag felt, act less as a carrying medium for the bitumens, but rather as a protection to the layers of bitumen. They are not suited for use with coal-tar pitch, but are not injured by hot asphalt. They are more expensive than rag felts, but have some peculiar and valuable qualities. Burlap made from jute decays easily when not protected. It is used in a few ready roofings with rag felts to increase their tensile strength, the need of which is not generally agreed to.

Built-up Roofs.

The bituminous roofings come ready to lay, or can be built up on the roof, using layers of saturated felt, mopped with pitch and properly protected. The built-up roof is especially valuable for flat surfaces. It can be made as heavy as desired and if properly laid and of good materials, gives a roofing which by long experience has been shown to be economical and efficient. Where the roof is to be subjected to wear and where the character of the construction warrants the expense, flat tiles or brick should be used as a protective coating to the roofing instead of gravel or slag.

For the flat roof built under average conditions, coal-tar pitch is recommended in preference to asphalt products. It is more easily handled, requires less skill, and while more material is necessary, it is still cheaper and in our opinion more certain results can usually be expected from its use when laid by the average contractor. The large amount of material, while heavy, has insulating value. Good results, however, can be expected from built-up roofs using good asphalt compounds where laid by skilled workmen.

When the slope of the roof is over three inches to the foot, the application of a built-up roof becomes more difficult for both coal-tar and asphalt, it being harder to get even mopping and there is more chance of accident for the men. The desirable straight run coal-tar pitch cannot be used, and it is necessary to add some stiffening material which is supposed to somewhat affect the life of the pitch. This must not be done except under supervision skilled in such work, and especial care must also be taken in the selection and application of the stone or slag coating.

Built-up roofs with a ready roofing for the coating sheet are proposed by various manufacturers. They should have their best value for steep slopes.

The advantages of a coal-tar pitch built-up roofing are such that it is recommended that where a permanent roof is desired and where the character of the structure allows, that the building be so designed as to allow its use. A flat roof makes an economical structure and has small fire hazard. A pitch of from one-half to one inch to the foot is better than anything steeper. With proper materials and application a life of from 15 to 20 years can be expected with a flat roof.

No contracts should be made for a built-up roof without a complete and positive specification including flashings, and the contract prices should not be less than those of the materials specified, plus a reasonable amount to cover the cost of laying and profit. Thorough inspection of workmanship and material is recommended.

Ready Roofing.

The ready roofing has better value for the steeper roofs than for those of small pitch. It averages much cheaper than the built-up types. Most kinds require occasional recoating to get a fair life. For flat slopes they are hard to lay absolutely tight, and they are not economical for a permanent structure, but on slopes of from three inches to the foot up, their use is more justifiable.

Ready or prepared roofings are recommended for use on small, temporary and other buildings, where the cost, considering maintenance, of more expensive roofings is not justified. They are also of value for steep slopes where a built-up coal-tar cannot be used, and for locations where the skilled labor necessary for a built-up roof is not available. The steeper the slope the greater their relative value and the wider their economical field. The heavier varieties are, in general, the more desirable because of their chance for longer life and their greater fire-resisting value. In making selections the reliability of the manufacturer, service tests and the cost should be governing factors.

On the steeper slopes the use of ready roofing shingles properly reinforced so as to prevent curling up at the corners and fraying on the exposed edges and laid shingle-fashion is growing. They are supposed to give better results than the rolled goods, but cost more. They would seem at least to be worthy of investigation.

Slate and Tile.

Slate makes a good roof if of good quality and properly watched. It breaks easily and cannot be walked on without danger to the slate.

Tile of good quality gives good results. It is not so tight as slate, but does not break easily. It has architectural value, and its use is growing, with improvement in the product and in the variety of colors.

Slate and tile of suitable quality, properly protected and fastened, can be recommended on roofs with a pitch of six inches to the foot or over, where expense is not the governing feature, and where they aid in producing the desired architectural effect, except that where there is much chance of driving snow, eight inches to the foot should be the flattest slope allowed.

Shingles.

Shingles of asbestos and Portland cement are of value. They have some elasticity and can be driven down tight.

Wood shingles are not now desirable for a railroad structure.

Cement Tile.

Small cement tile are not considered of much value, being brittle. Large cement tile reinforced, laid without sheathing directly on the purlins are in use on shops and freight houses and seem to have considerable merit. Glass can be introduced into them, avoiding the expense of skylights. We are not ready to recommend them for plastered or heated buildings or offices where an occasional slight leak would be disastrous.

Metal Roofings.

Metallic roofings with steel as a base are not recommended for general use on permanent buildings. They require continual maintenance. Galvanizing of steel seems to be well worth the expense. Tests of lead covered steel sheets indicate good results. Large sheets of corrugated galvanized steel can sometimes be used economically where the building is not to be heated.

Small metallic shingles of either copper, tin, galvanized steel plate or specially pure iron are not recommended for general use. They are very light in weight and serve a purpose, particularly in the dry climate of the Southwest. In using metals, every effort should be made to secure those of good quality. The pure irons have value. Their virtues have perhaps been overstated, but they are not expensive, and experience seems to indicate considerable economy by their use as a substitute for wrought-iron and steel. Copper, lead, zinc and Monel metal are used for roofing, but they are not of value for ordinary railroad structures.

General.

In the laying of all roofings throughness in preparation of flashings and work around openings is of vital importance. To get a satisfactory roof there must be a stable structure, careful attention must be given to the design of gutters, and with some types particularly, there must be systematic inspection and regular repairs. In buying a roof its fire resisting qualities, to a considerable extent depending on the quantity of material as well as its quality, are of great importance.

A building covered with a heavy coal-tar pitch and gravel roofing is a better fire risk than one covered with corrugated steel sheets, or with a light ready roofing.

The practice of depending merely upon guarantees in selecting roofings cannot be trusted to secure proper results. It does not pay to put a cheap roof on a good building. The annoyance and indirect expense occasioned by leaky and short-lived roofs are rarely compensated for by any possible saving in first cost.

PRINCIPLES COVERING DESIGN OF INBOUND AND OUTBOUND FREIGHT HOUSES.

The following report on Freight House Design was presented for publication in the Manual, and was intended to replace the conclusions relating to inbound and outbound freight houses now in the Manual.

In outlying districts, where the fire hazard is not great and business is not large, and the building laws will permit, frame freight houses having wood floors on joists, studding covered with wood sheathing or metal siding and wood rafters and sheathing covered with appropriate roofing, are fairly satisfactory and cost less than other sorts. Floor for this type should ordinarily be designed to carry 250 lbs. per sq. ft. With such construction there should be ventilation beneath the floor, but the access to the space under the house should be prevented to avoid the accumulation of rubbish and increased fire hazard. But even where a frame house is to be used, it is better practice to use a filled concrete foundation, eliminating some fire hazard and decreasing maintenance charges.

Where the laws prohibit frame structures and the value of the freight stored is considerable and it is necessary to build freight houses of so-called fireproof material, floors should be placed on a fill between foundation walls, and the exterior walls should be of masonry or steel frame covered with metal siding. Roof trusses, framing, etc., can be of wood, covered with appropriate roofing, but to provide better fire protection, fireproof construction may be used.

Fire walls of brick or other non-combustible material should be located so as to conform to the requirements of the underwriters. The strictest practice limits the area between firewalls to 5,000 sq. ft. This especially applies to houses with no outside platform. In wide houses, this locates the walls rather close together for economical operation. Fire walls should in no case be more than 200 ft. apart.

Doors in fire walls should be as limited in number as possible, no one door opening should exceed in area 80 sq. ft. and all should be equipped with automatic fire doors.

Where non-fireproof construction is used, inflammable parts of the structure should be covered with fireproof material for a distance of at least 5 ft. on either side of the fire wall. This refers especially to overhanging roofs.

Where but a single house is needed, a width of from 30 to 40 ft. is good practice. When the amount of freight handled is sufficient to justify it, separate houses for inbound and outbound freight are desirable. When these are provided, the outbound house should be narrow, not more than 30 ft. wide, and the inbound 40 to 70 ft. wide.

A platform 8 to 10 ft. wide, along the track side of the house, avoids the necessity of considering the location of doors in spotting cars on the track next to the house, and also eliminates the necessity of keeping an aisle-way inside the house on the track side. It should be at least 8 ft. wide, to give sufficient room for two trucks to pass. The distance from the center of the nearest track to the face of the platform or freight house should not be less than 5 ft. 9 in. where tracks are on tangent. The top of rail should be 4 ft. below the floor or platform level at the track edge, where refrigerator cars are not to be handled in any quantity. With occasional refrigerator cars, the doors can be opened before the cars are set.

Where refrigerator cars are to be handled regularly, the height should not be more than 3 ft. 8 in., this conforming to the recommendations of the M. C. B. Association. The alternative of spacing tracks at least 7 ft. from platforms is usually expensive at important terminals.

The platform should be protected by an overhanging roof, not greater than the width of the platform, and at least 10 ft. above the platform level. Where state laws permit, protection over the cars is often used. This should be at least 17 ft. above the top of rail and should preferably extend to within 18 in. of the middle of the car. There should also be an overhanging roof or other protection on the team side to protect goods while being unloaded, the overhang to be at least 4 ft. and preferably more, 12 ft. being needed to give protection from a driving rain.

Freight houses without outside platforms would seem desirable in some localities, especially in northern climates, where there is considerable snow and sleet, as these house can be entirely closed, except for that part of the house where the freight is being received or loaded. At some points where ample track room is not available, the elimination of the outside platform gives better results.

With this type it is necessary to leave more trucking space inside the house longitudinally the full length of the building. With the house congested with freight, it is difficult to keep the aisleways from being crowded so that it is almost impossible to get through with a truck that is loaded with any large packages.

On the street side, the floor of the inbound house should be from 3 to 4 ft. above the street grade, depending on the type of trucks in use. At the outbound house the height should not exceed 3 ft. To assist truckers, the floor of the inbound houses should be sloped toward the street, approximately 1 in. in 8 ft., this being for the house proper. An outside platform on the track side should slope approximately 1 in. toward the tracks for drainage. For the outbound house, the floor should slope from the street to the edge of the platform alongside the car, not more than 1 in. in 8 ft.

Several kinds of doors are satisfactory, counterbalance lift (either folding or not), rolling shutters and parallel sliding. It is advantageous to have as much door opening on the team side as possible, and with all types of doors except the last, all of the house can be opened except for the space occupied by posts. With the parallel sliding doors, not more than half of the space can be opened up. They are all right on the track side. Without the outside platform continuous doors should be used, so that an opening can be obtained at any point opposite a car door. Where an outside platform is provided, a door in each panel is sufficient. Considering the average length of cars and economy in framing, 22 ft. is a good panel length.

It is advantageous to have the floor entirely free from posts; but in houses approaching 50 ft. in width, the saving made by using posts becomes great enough to offset the advantages due to their omission. On account of light weight merchandise being piled high on trucks, it is desirable to have the edge of the eaves at least 14 ft. above the level of the driveway, where local conditions will permit. As all freight trucked into the house and cars must pass through the car door, the height of the freight-house door need be little greater than the car door. All doors should be at least 8 ft. high. On the team side a greater height might at times be convenient.

Natural light should preferably be provided in the sidewalls above the doors. Skylights in the roof are expensive to maintain and ineffective, as is also glass in canopies or on any plane approaching the horizontal. Artificial light is needed for operation at night and during the late afternoon in the winter, and, wherever possible, electricity should be used, with wires run according to the specifications of the National Board of Underwriters. One or more lines of lights should be run the full length, inside the house, and one line over outside platforms. Another circuit should be run along the face of the platform wall parallel to the track, with outlet boxes not over 40 ft. on centers, with socket arrangement for push plug for use in attaching an extension cord to hang inside the car to provide light for loading on dark days and evenings during the winter season. The need of other outside lights on the train side is questionable. The type of lights will depend somewhat on the height of the ceiling. All lights should be stationary and operated in circuits from conveniently located panel-boards. The circuits should be carefully planned, so as to allow maximum economy in use of lights.

Where water pressure is available standpipes and hose racks not more than 150 ft. apart should be provided for fighting fire. By putting them on the fire and end walls they are thought to be more accessible and less liable to be blocked by freight than if located at other points, but by putting them about 40 ft. from the end of each section, fewer hose connections are necessary to cover the entire station. By putting them 100 ft. apart, 50 ft. of hose will be sufficient for each connection, more than this being somewhat inconvenient to handle. As there is no heat in the house, the valve controlling the water supply should be located below the frost line and controlled by a stem, with a hand wheel above the floor. In houses where electricity is available, a small red light should be over each hose rack to designate the location of the fire-fighting apparatus, this light to be kept burning at all times.

Chemical extinguishers should be provided in addition to the hose and standpipes. As they are put out of service by freezing, some provision should be made for replacing them or keeping them warm. Tanks containing a solution of calcium chloride are used successfully. Where a watchman is needed,

a watchman's clock system, with a registering clock in the freight office and stations located at various places throughout the freight houses, should be installed.

In outbound houses sufficient scales should be provided so that all the freight can be weighed. In inbound houses where little of the freight is weighed, at least one scale should be placed in each section. The scales should have a minimum capacity of four tons. A successful dial scale expedites the handling of freight.

In inbound houses a room should be provided to house "over, short and damaged freight" enclosed so that it can be kept locked. In large layouts, particularly where there is considerable transfer business, a room should be provided for repairing broken packages, such as crates, boxes, barrels, etc.

In large houses a separate office should be provided for the foreman. If this can be an elevated structure, it will save floor space. In large houses the general office for the clerks and the private office for the agent should be provided by a second story over the inbound house, and in the second story should also be a place for files and stationery cases, toilets and locker facilities for clerks. This all should as far as possible be in view from the desks of the agent or chief clerk. The cashier and his clerks should ordinarily be located on the first floor.

Where possible, it is preferable to have the clerks' and agent's offices, the toilet room, etc., for the freight handlers and draymen, the room for "over, short and damaged freight," and the cooperage room for repairing broken packages, etc., all in one section. In the larger terminals provision may be wanted to care for perishable freight, and when it is provided, it should also be located in this section.

The basement should house the heating plant, with room for coal, and is sometimes a good place for toilets for the freight handlers and draymen, and for locker and lunch rooms for the freight handlers.

Where both outbound and inbound houses are arranged in the same layout, a transfer platform is usually included. One of the best designs for covering these platforms in a butterfly shed, with the post located in the center on the platform. Where this design is used, the platform should not be less than 12 ft. wide, to provide room for trucks between the posts and the cars.

For loading and unloading agricultural implements and other large, bulky packages, platforms should be built, usually as extensions to the inbound and outbound houses, with ramps on the ends of these platforms. The extension platform should be at least 8 ft. wide and, if possible, 16 ft. wide, especially if covered. A stub end track butting against a platform with a ramp is valuable. Where no gantry crane is provided in the freight yard, a stiff leg or pillar crane should be provided on the end of the extension platform.

On the team side of all freight houses a fender should be provided to protect the walls from the wagon wheels. A good type is one made up of an 8-in. by 10-in. timber set on brackets, with a spacer or separator to keep the timber approximately 2 in. away from the wall, so that dirt will filter through and not collect on the fender.

SHOP FLOORS.

The following report on shop floors contains detailed information and diagrams applicable to freight house floors, and can be considered as supplementary to the report of last year on that subject.

The essential requirement of a shop floor is a good hard wearing surface that is level, smooth, easy on the feet, easy to truck loads over and capable of carrying heavy loads. Different typical types of construction of shop floors are illustrated by the following diagrams:

Fig. 1. Cinder or Gravel Floor, Especially Suitable for Blacksmith Shops, Foundries and Boiler Shops.

Cinder or Gravel Floor.—Fig. 1 is a type of floor in general use, one that is best adapted for blacksmith shops and foundries. It is made by filling in the space between foundation walls, preferably with sand or gravel, and bringing the filling up to the required grade, thoroughly compacting it as it is placed. The filling should be well flooded, rolled and tamped. A five to ten-ton roller should be used where possible.

The minimum depth of the finished floor should be 8 in. and if the top surface of the ground is soft, it should be removed below this depth. For a top wearing surface, hard screened cinders or stone screenings should be used to a depth of about 2 in., and this should be thoroughly wet down and rolled to a firm hard surface. Where clay is available it often can, with advantage, be mixed with the top surface and rolled into place. This makes a hard and more compact surface. Crude oil also, when mixed with the top surface, tends to harden it, and helps to prevent the wearing surface from becoming broken up.

This type is not well adapted for trucking, and often an industrial track about two feet wide with small push cars or a close-planked runway may be desirable where the most material has to be moved. Special foundations are necessary for all machinery.

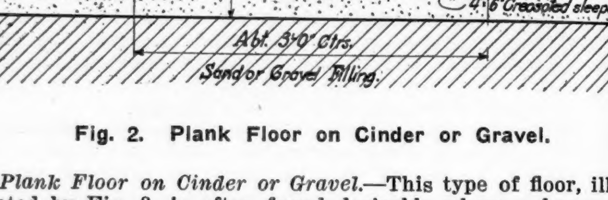


Fig. 2. Plank Floor on Cinder or Gravel.

Plank Floor on Cinder or Gravel.—This type of floor, illustrated by Fig. 2, is often found desirable where a heavy fill inside of foundation walls is required, where settlement may occur, and where the type of floor shown in Fig. 1 would not answer on account of the volume of trucking required, or on account of the necessity of gathering up and saving scrap material, as in a machine shop.

It consists of planking, spiked to sleepers resting on the filled material between the foundation walls. The filling, preferably sand or gravel, should be settled as mentioned in connection with Fig. 1, and should be brought up to within 9 in. of the finished floor grade. On this should be placed 6 in. of cinders, gravel, or other material of a porous nature, in the top surface of which 4-in. by 6-in. sleepers are embodied, spaced about 3 ft. centers. They should be laid with running broken joints. This makes a fairly good working surface, which will last at least four years, at which time all settlement should have taken place in the filling, and a better type of floor can be used. Long leaf yellow pine will last longer than short leaf yellow pine, but will cost more. Fir and hemlock will longer resist decay than will short leaf yellow pine, but they will not wear as long, and are not as good as long leaf yellow pine. Special care should be taken to have the sleepers and plank thoroughly seasoned.

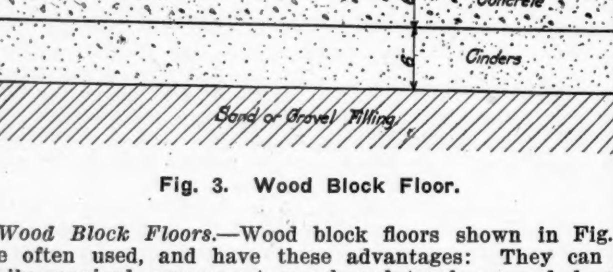


Fig. 3. Wood Block Floor.

Wood Block Floors.—Wood block floors shown in Fig. 3 are often used, and have these advantages: They can be easily repaired, are easy to work and truck on, and do not damage falling tools. They need a concrete base to distribute heavy loads which may bear on a few blocks only.

The filling between foundation walls is done as in Fig. 1, and includes a 6-in. bed of compacted cinders. On the cinders is laid a 6-in. course of 1:3:5 concrete. Steel reinforcement may often be placed in the concrete to advantage, particularly over soft spots in the filling, or where heavy loads are apt to be placed. The reinforcement should be placed either near the top or bottom surface of the concrete, depending upon local conditions. Sand should be spread over the concrete, and brought with a board or template to a uniform thickness which, when compacted, will amount to one inch.

On the sand bed place the wood blocks, which should be of

an even thickness of at least 4 in. The blocks should be cut across the grain so that they can be laid with the ends of the fibre exposed to wear. They should be uniform in width but may be variable in length, although blocks of a uniform length can be laid quicker, and more cheaply.

Wood blocks should be creosoted. Generally they are of short leaf yellow pine, although long leaf yellow pine blocks give the greatest wear. The blocks should be laid with the fiber vertical, and with close joints, with at least a two-inch lap. Expansion strips one inch in thickness should be placed every 50 ft. across building and at the sides of the building, or at any break in the floor surface. The blocks should be tamped, or rolled to an even surface, joints filled to within one inch of top surface with sand, and the balance of the joints filled with No. 2 street pitch. Immediately after placing

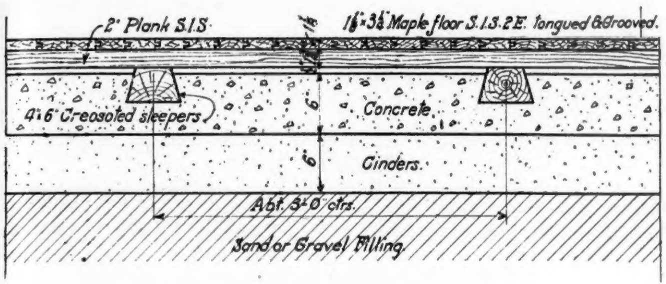


Fig. 4. Plank Floor on a Concrete Base.

the pitch there should be spread hot dry sand or gravel over the blocks to take up surplus pitch.

Asphalt Block Floors.—Asphalt blocks, about 4 in. by 12 in. by 4 in., are sometimes used to advantage, as they come on the job all ready, and can be laid like wood blocks or like brick. They do not need expansion joints nor does the laying of them require any skilled supervision. They do not heave, they stay smooth and wear slowly without chipping, except that where there is continuous dripping of oil, as directly under a vise, they soften and wear faster than at other points. They can be more easily taken up and repaired than other types.

Plank Floor on Concrete.—Fig. 4 shows a wooden floor with a concrete base. It is a good type of floor, as it gives a fine surface either to work on or to truck over. However, it is expensive.

The filling and concrete base should be placed as for a wood block floor, Fig. 3, except that in the top surface of the concrete there should be embedded 4 in. by 6 in. creosoted sleepers. On these sleepers should be laid 2-in. plank, dressed to even thickness and width. This should be laid with running broken joints. On the planks should be laid a top wearing surface of 1⅛ by 3¼ D. & M. maple flooring with ends matched, laid parallel to the direction of the maximum trucking, and with running broken joints. The flooring should be end matched and bored for nailing, for which there is little, if any, extra cost.

This type of floor should ordinarily last from ten to twelve years, and generally fails from dry rot to the sleepers and the underfloor. Additional life may be obtained by creosoting the sleepers and underfloor, and by giving the top surface of the finished floor a good mopping of hot linseed oil which also tends to lessen buckling.

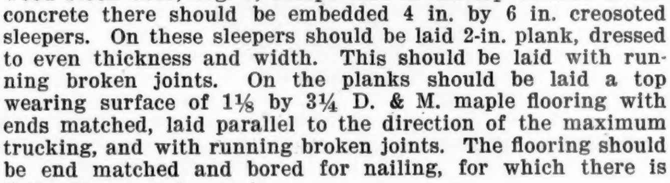


Fig. 5. Tar-Rock Floor.

Wood Floor Set in Tar Pitch.—Fig. 5 shows a wooden floor with a concrete base, the wooden sub-floor being set in a top coat of pitch and sand, spread over the concrete. Either Portland cement concrete or a tar concrete can be used as a foundation. This is a more permanent type of floor than that shown under Fig. 4, unless in the latter case both the sleepers and the underplank be creosoted.

Concrete Floor.—Fig. 6 makes a cheap and fairly permanent floor, is easy to truck over, is easily cleaned, is sanitary, and has the advantage that no special foundations have to be provided, except for the heavier types of machinery. Light machinery is simply bolted to the floor. Industrial tracks may be easily and cheaply installed in the floor with the head of the rail flush with the top surface. This floor, however, easily damages falling tools, it is hard to work on, and quite easily becomes worn in spots.

Asphalt Floor.—Fig. 7 is considered to be an ideal floor for shops, if properly laid, with the correct materials and

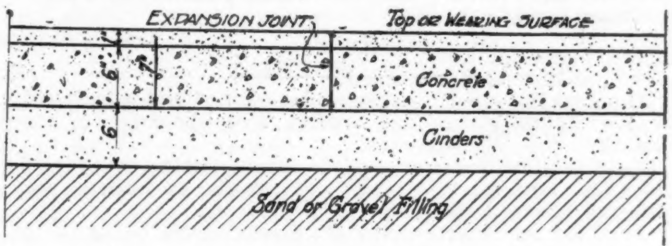


Fig. 6. Concrete Floor.

mixtures. Experienced supervision must be employed to get the best results. Similar floors are still in service and in fair condition after having been laid 25 years.

Floors of this type will outwear others several times. They give the qualities which are desirable in a floor, and are without the objectionable features which have been mentioned in connection with other floors. They are easy to walk on and truck over, and the more the traffic the more dense and durable they become. They do not grind away material under truck traffic, they do not easily wear uneven, do not easily crack or disintegrate, are noiseless and dustless, and can be kept clean by broom or mop, or occasionally by flushing with a hose. They are sanitary, water- and fireproof, and are easily repaired. The filling and concrete subfloors are laid the same as for other types of floors. The top of the concrete

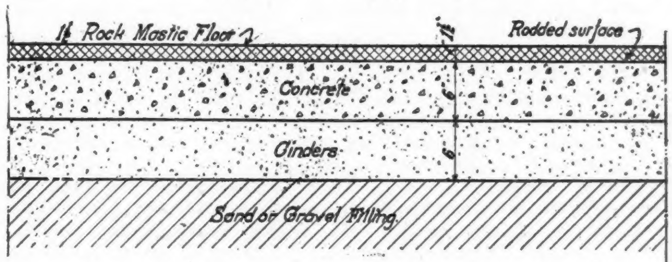


Fig. 7. Rock-Mastic Floor.

should be drawn out under a straight edge, struck off, but not troweled.

Mastic blocks should be delivered on the ground plainly marked with name of the brand, and broken up before placed in the mastic boiler. Asphalt flux should then be added and both allowed to cook, until the mastic blocks are entirely melted. Washed torpedo gravel, torpedo sand, crushed limestone or granite, in the proper percentage to give the required hardness, should then be added, and thoroughly mixed into the mass by iron stirring rods, and the temperature of the mixture brought to 450 degrees Fahrenheit. The gravel or stone must be thoroughly dry before being put into the mastic and should be clean, well-graded material, which contains no particles larger than would pass through a ¼-in. mesh. Native bitumens do not give as good results as do the imported mastics.

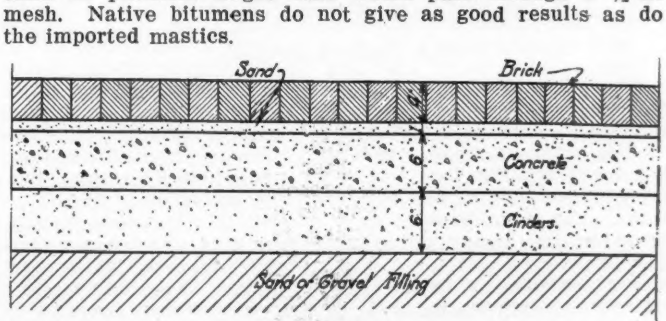


Fig. 8. Paving Brick Floor.

Brick Floor.—Fig. 8 shows a brick floor with a concrete base. Such floors are easily repaired, easily cleaned, sanitary, fairly cheap, but are hard to truck over, hard for men to work on and hard on falling tools. The filling, concrete base and one-inch sand cushion are placed as for a wood-block floor. Over this is laid the brick floor. The bricks should be vitified

repressed pavers laid edgeways and carefully tamped or rolled to insure an even top surface. The intervening space between bricks should be filled with Portland cement and sand of a one-to-one mixture, and poured as a thin grout, followed up with a stiffer mixture, and covered over with sand. Expansion joints are necessary, as for creosoted blocks, but the joints need not be so large.

CONCLUSIONS.

The committee recommended:

(1) That the report or Roofing be adopted and substituted for the matter under that heading now appearing in the Manual.

(2) That the report on Freight House Design be adopted and substituted for the conclusions relating to inbound and outbound freight houses now in the Manual.

(3) That the report on Freight House Floors be approved for publication in the Manual.

Maurice Coburn (Vandalia), chairman; M. A. Long (B. & O.), vice-chairman; G. W. Andrews (B. & O.), C. F. W. Felt (A. T. & S. F.), J. P. Canty (B. & M.), G. H. Gilbert (Q. & C.), O. P. Chamberlain (C. & I. W.), A. T. Hawk (C. R. I. & P.), D. R. Collin (N. Y. C. & H. R.), H. A. Lloyd (Erie), C. G. Delo (C. G. W.), P. B. Roberts (G. T.), C. H. Fake (M. R. & B. T.), W. S. Thompson (P. R. R.), Committee.

Discussion on Buildings.

Maurice Coburn, chairman, presented the report.

(The report on routing was accepted.)

M. A. Long, vice-chairman, presented the part of the report dealing with "Principles covering Designs of Inbound and Outbound Freight Houses" and said:

Add to the first paragraph "This report does not cover freight piers and deals only with single story freight houses where the mechanical handling of freight is not necessary." Also add to paragraph beginning "Where refrigerator cars —" "Many roads are building cars that are lower than the maximum figures given above, and each road in deciding the height of platform at the top of rail should take into consideration the size of car that will be used on its lines."

Mr. Long: I move that the matter just read be accepted and approved for publication in the Manual.

C. S. Churchill (N. W.): The clearance of the face of the platform or freight house is given as not less than 5 ft. 9 in. I am afraid that is too close, according to proper clearances and is against the laws of several states.

Mr. Long: I suggest in line with Mr. Churchill's remarks that this section be amended to read 5 ft. 9 in. to the base of the platform and 6 ft. to the base of the freight house from the center of the track.

Mr. Coburn: The committee feels that the part on Shop Floors of the report is rather incomplete.

Mr. Downs: I move that it be received as information only.

(The motion was carried.)

RAIL

The work outlined for the year was as follows:

(1) Recommend standard rail sections.

(2) Continue investigation of rail failures and deduce conclusions therefrom.

(3) Continue special investigation of rails.

(4) Rail joints.

STANDARD RAIL SECTIONS.

The information gained to date by the study of the present A. R. A. standard rail sections, types A and B, is not such as to warrant the Committee in recommending changes at this time in those standards. The question of sections heavier than 100 lbs. has been under consideration, but no definite conclusions were reached concerning such sections. The committee expects to give this question further consideration during the coming year, and a sub-committee has been appointed for this purpose. The investigations of the committee up to this date indicate the inadvisability of railroads purchasing rails of lighter sections than 80 lbs. per yard for replacements in main tracks on districts thereof that have conditions or traffic which places them under Class "A" or Class "B," according to the classification of the American Railway Engineering Association.

STATISTICS OF RAIL FAILURES.

Statistics of rail failures for the year ending October 31, 1912, were issued in Bulletin No. 157 for July, 1913. [Abstracted in Railway Age Gazette, Sept. 19, 1913.] The responses this year were more complete and in better form than ever before. Attention should be called, however, to the fact that many roads showed some carelessness in reports, particularly the "Position in Ingot" report. The requests for reports prepared so that they could be blueprinted was in many cases disregarded.

SPECIAL INVESTIGATIONS.

During the year 1913, special reports or papers were presented to the Rail Committee as follows:

No. 34, January, 1913, by M. H. Wickhorst, Influence on Rails of Amount of Draft in Blooming (Bulletin 159).

No. 35, March, 1913, by M. H. Wickhorst, Comparison of Basic and Acid Open-Hearth Rails, and Influence of Reheating Cold Bloom (Bulletin 159).

No. 36, April, 1913, by H. B. MacFarland, Influence of Seams or Laminations in Base of Rail on Ductility of Metal (Bulletin 160).

No. 37, June, 1913, by M. H. Wickhorst, Seams in Rails as Developed from Cracks in the Ingot (Bulletin 160).

No. 39, October, 1913, by M. H. Wickhorst, Influence of Aluminum and Silicon on Bessemer Ingots and Rails (Bulletin 163).

In addition to the work done by Mr. Wickhorst, the committee has endeavored to have the manufacturers publish the results of some of their own special investigations into the characteristics of rails under different processes of manufacture, and hopes to be able in future to present some such reports.

J. A. ATWOOD,
Chairman Committee on Rail.

The general line of investigation which the committee has in view for Mr. Wickhorst is submitted below and embraces a great deal more work than he can cover in any one year, but it is well to keep before us the subjects which are important and demand attention.

The main point kept in mind in the work of the last few years has been to conduct it so as to bring out information useful in improving rails for the purpose of making them uniformly safe, and it is probable that this must continue to be our guiding principle for some time to come. Investigations intended to improve the wearing properties of rails must, it would seem, be considered secondary to those which have uniform safety as the prime consideration.

Several years ago, at the time the committee took up its experimental work, our information as to the causes of rail failures was in very indefinite shape, but we have now arrived at a point where we may feel considerable confidence that we have the correct diagnosis of the causes of most of the rail failures. Most of the failures may be divided into four classes, as follows: crushed and split heads; broken rails (square and angular breaks); broken bases (crescent breaks); and transverse fissures (oval spots in rail head).

Our investigations show that crushed and split heads are attributable to the interior condition of the ingot from which the rail was rolled, known as segregation. This is an excessive concentration of carbon and phosphorus in the interior and upper part of the ingot and is to be avoided by obtaining

well deoxidized quiet setting steel, and by not using ingots with "horny" tops.

Investigation seems to indicate that broken bases and at least a very large per cent. of broken rails have their origin in seams in the bottom of the base. Our work during the past year shows that such seams (at least a part) start from cracks in the surface of the ingot and are produced in the process of making the bloom, and that the details at this stage of the rolling are very important.

These three types of failure include about 90 per cent. of the rail failures of the country and are thus to be traced to the ingot and the initial stages of the rolling.

The other type of rail failures, transverse fissure, or oval spot in the rail head, we are as yet unable to state the cause of, but we expect to give this matter considerable attention during the coming year. There is still another type of failure, cracked web, that we have but little definite information about.

Among the subjects needing investigation, the following may be listed:

Making Ingots.

(1) Influence of height of ingot on segregation and interior cavities, open-hearth steel.
(2) Influenced diameter of ingot, open-hearth steel.
(3) Influence of rate of pouring the ingot.
(4) Influence of temperature of liquid steel when poured into the molds.
(5) Influence of thickness of mold.
(6) Influence of taper of mold on ingot cracks.

Making Rails.

(7) Influence of temperature of rolling on high-carbon open-hearth rails.
(8) Causes of seams in base of rails.
(9) Influence of rate of reduction in rolling.
(10) Relation between shrinkage and grain size.
(11) Influence of methods of cooling on cooling beds.
(12) Effect of cold straightening rails.
(13) Influence of length of time in soaking pit on grain size and other rail properties.

Composition.

(14) Quantitative influence of carbon on deflection and ductibility.
(15) Quantitative influence of phosphorus on deflection and ductility.
(16) Quantitative influence of manganese on deflection and ductility.
(17) Influence of titanium on open-hearth ingots and rails.
(18) Influence of aluminum on open-hearth ingots and rails.
(19) Influence of sulphur in production of seams.

Miscellaneous.

(20) Cause of transverse fissures in rail head.
(21) Investigate electric steel rails.
(22) Influence of low temperature on ductility and other properties of rails.
(23) Influence of heat treatment on the properties of rail steel.
(24) Influence of carbon on resistance under rolling loads.

RAIL JOINTS.

By circulars Nos. 1347 and 1348 of the A. R. A., information in regard to the length and drilling and the individual preference for four- and six-hole bars on a large number of representative railroads of the country has been obtained. In this circular a proposed drilling for four- and six-hole bars was submitted for criticism. The replies have been tabulated. A study of the information shows, for instance, the distance between centers of the middle holes at the joint to vary from 3⅞ to 8½ in. It is further found by studying the tables that three distances, 5 in., 5½ in., and 6 in. are used by a large number of companies. The committee on Track recommended a standard spacing of 5 in., which was adopted in 1904 and appeared in the Manual. This recommendation was withdrawn.

From the information supplied, the committee is of the opinion that it would be very difficult to get all the roads to agree to a single standard drilling, for the reason that there is a very great feeling against change of standards. The committee is of the opinion that this feeling is more or less of a prejudice and has no substantial foundation. It is also the invariable rule when new rail is laid to purchase new angle bars, but by and by, the old standards will disappear and modern standards will take their places in case of changes. After canvassing the matter thoroughly, the sub-committee voted in favor of a drilling spaced uniformly 5½ in. for both 4 and 6 hole bars.

A study of the length of bars used shows that for six-hole bars it varies from 26 to 44 in., and for four-hole bars, from 21 to 27 in. It would appear that there is no good reason for variation between the limits of 30 and 36 in. for six-hole bars, and between 24 and 26 in. for four-hole bars.

With the spacing of holes recommended by the committee, 24 in. is a satisfactory length for four-hole bars, and 32 in. a satisfactory length for six-hole bars, where suspended joints are used.

STRESSES IN RAIL.

After considering the subject of rail stresses, the committee is of the opinion that no material benefit is to be gained by further mathematical investigation and discussion, unless accompanied by actual tests under service conditions, and recommends that the Rail committee authorize that steps be taken for a series of tests to determine these stresses under varying conditions, and as a means of accomplishing this, it is suggested that a combination be formed of the Rail committee with the Roadway, Track and Ballast committees, for conducting these tests for rails, jointly with the tests proposed to be made by the three last named committees, through the proposed joint committee from the A. S. C. E. and the A. R. E. A."

At the last meeting of the Board of Direction this whole subject was referred to a joint committee of those two societies. The Rail committee will therefore take no further action on this subject.

REVISION OF SPECIFICATIONS.

There has been considerable discussion between the members of the Rail committee and members of the Manufacturers' committee as to some parts of the specifications for carbon steel rails. The meeting at New York was a joint meeting, at which the Manufacturers' committee was present, and at which these matters were discussed. As a result of these discussions, the committee has revised the specifications in the following respects:

Explanation of Changes.

Section 1 of the 1913 specifications has been changed to include section 35, which latter requires the loading of rails to be done in the presence of the inspector. Section 1 of the proposed 1914 specifications now reads: "Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made and *loaded* in accordance with the terms of the specifications."

Under the subject of chemical composition, the carbon limits of open-hearth rails of 85 to 100 lbs. per yard have been changed from 0.63 to 0.76 per cent. to 0.62 to 0.75 per cent. This was done mostly to conform to the present requirements of the New York Central Lines and the Pennsylvania System.

Section 6 of the 1913 specifications, permitting an increase of carbon for a decrease in phosphorus, has been omitted. The type of rail failure known as "transverse fissure" in the head of the rail seems to occur mostly in rails containing over 0.80 per cent carbon, and it is thought well for the present to keep the maximum carbon limit below this amount in weights of rails covered by these specifications. Omitting this section changes the numbers of all the succeeding sections.

Section 13 of the 1913 specifications reading, "The test shall, at the option of the inspector, be placed head or base upwards on the supports, etc." has been changed in section 12 of the new specifications to read: "The test piece shall ordinarily be placed head upwards on the supports, etc." The manufacturers complained that the constant reversal of the position of the rail on the supports wore the supporting surfaces and the striking die so that it was difficult to maintain these surfaces in proper condition for making a fair test of the rail.

Section 16 of the 1913 specifications has been revised as section 15 of the new specifications by adding a definition of interior defect as follows: "The words 'interior defect,' used below, shall be interpreted to mean seams, laminations, cavities or interposed foreign matter made visible by the destruction tests, the saws or the drills."

Section 24 of the 1913 specifications deals with the length of rails and allows a variation of ¼ in. from the specified lengths. This part has been revised in section 23 of the new specifications to read as follows: "A variation of ¼-in. from the specified lenghts will be allowed, *excepting that for 15 per cent. of the order a variation of ⅜-in. from the specified lengths will be allowed.*" The manufacturers claimed

that a variation of not more than ¼-in. on all rails is not practicable, and although this has been the requirement, it has not been strictly enforced by the inspectors.

Section 31 of the 1913 specifications reads, "Circular holes for joint bolts shall be drilled accurately in every respect to the drawing and dimensions furnished by the Railroad Company." This has been amended in section 30 of the proposed 1914 specifications to read as follows: "Circular holes for joint bolts shall be drilled to conform to the drawing and dimensions furnished by the Railroad Company. A variation of $\frac{1}{32}$-in. in excess in size of holes will be allowed."

J. A. Atwood (P. & L. E.), chairman; W. C. Cushing (P. L. W.), vice-chairman; E. B. Ashby (L. V.), A. S. Baldwin (I. C.), J. B. Berry (C. R. I. & P.), M. L. Byers (D. & H.), Chas. S. Churchill (H. & W.), G. M. Davidson (C. & N. W.), F. A. Delano (Monon), P. H. Dudley (N. Y. C. & H. R.), C. H. Ewing (P. & R.), C. F. W. Felt (A. T. & S. F.), L. C. Fritch (C. G. W.), A. W. Gibbs (P. R. R.), A. H. Hogeland (G. N.), C. W. Huntington (M. & St. L.), John D. Isaacs (S. P.), Thos. H. Johnson (P. L. W.), Howard G. Kelley (G. T.), C. F. Loweth (C. M. & St. P.), H. B. MacFarland (A. T. & S. F.), R. Montfort (L. & N.), C. A. Morse (C. R. I. & P.), J. P. Snow (Consulting Engr.), A. W. Thompson (B. & O.), R. Trimble (P. L. W.), Geo. W. Vaughan (N. Y. C. & H. R.), M. H. Wickhorst, Committee.

APPENDIX F.

INFLUENCE OF ALUMINUM AND SILICON ON BESSEMER INGOTS AND RAILS.

By M. H. Wickhorst, Engineer of Tests, Rail Committee.

An investigation was made concerning the influence of aluminum on Bessemer ingots and rails when added to the molds while pouring the steel and at the same time some tests were made on the influence of silicon on Bessemer rails when added as ferro-silicon to the molds. Four ingots were split open and a chemical survey made of them. Eleven ingots were rolled into 85 or 90 lb. rails and used for drop tests and transverse tests of the base. This work was done at South Chicago, Ill., at the works of the Illinois Steel Co., who kindly furnished all the material and facilities for the investigation.

Five ingots were of untreated Bessemer steel, eight were treated with aluminum varying from 1 to 10 ounces of aluminum per ton of steel and two ingots were treated with additions of ferro-silicon equivalent to .1 per cent. and .2 per cent. of silicon respectively. These latter were rolled into rails. The ingots used for splitting and chemical survey had about 0.44 per cent. carbon. The plain ingot had a large central cavity or pipe in the upper part of the ingot and a large number of small elongated holes along the sides in the upper part. This ingot also had a raised top. The other three ingots treated respectively with 1 oz., 2 oz. and 5 oz. of aluminum per ton of steel, had somewhat larger pipes but were free from the small elongated holes along the sides. They had flat or sunken tops. Expressed differently, the aluminum treated ingots had larger pipes but contained denser steel around the pipes. One ounce of aluminum per ton had considerable influence in this direction and the effect increased a little with the increase of aluminum.

A chemical survey was made of each of the ingots by means of 15 samples from each of five vertical rows from one-half of the section face, making a total of 75 samples from the ingot, minus the samples which could not be taken on account of cavities. On each sample determinations were made of carbon, phosphorus and sulphur and on some of them, of manganese and silicon also. The chemical surveys showed a more even distribution of the material in the aluminum treated ingots. The treated ingots showed less segregation or concentration of carbon, phosphorus and sulphur in the interior and upper part of the ingot. Both plain and treated ingots showed "soft centers" in the lower part of the ingot, that is, there was negative segregation of carbon, phosphorus and sulphur in the interior and lower part of the ingot. The walls of the treated ingots showed a fairly uniform composition throughout their heights. The plain ingot showed a considerable softening or negative segregation in the upper corners. The carbon, phosphorus and sulphur increased in the wall down the ingot until the average composition of the steel was reached at about one-third of the height from the top, after which the wall remained of about uniform composition.

Rails were made of steel of two grades of hardness, one of about 0.45 per cent. carbon rolled into 85 lb. rails and the other of about 0.61 per cent. carbon rolled into 90 lb. rails. Some were of plain steel, some treated with aluminum varying from 2 oz. to 10 oz. per ton and two were treated with 0.1 and 0.2 per cent. respectively of silicon added as ferro-silicon.

In the drop tests, the use of aluminum was in general attended with a considerable increase in ductility in the upper part of the bar, where the ductility was low in the plain steel, especially with the higher carbon. The addition of silicon had a similar effect, especially with the 0.2 per cent. addition. With the 0.45 per cent. carbon steel, the average ductility of the whole bar was about the same in the aluminum treated as in the plain steel. With the 0.61 per cent. carbon steel, the average ductility was considerably greater in the aluminum treated bars.

The aluminum additions and the larger addition of silicon were attended with interior flaws extending downward a considerable distance (as high as 30 to 45 per cent. of the weight of the ingot) from the top end of the bar, while with plain steel interior laminations as seen in the fractures of the drop test pieces were absent or close to the top end. The aluminum and silicon additions it will be remembered were made to the molds while pouring the steel and this investigation does not show whether the interior laminations in the rails would occur in the same way if the additions were made to the ladle before pouring the steel into the molds.

Incidental to this work, some results were obtained concerning the influence of carbon on ductility as measured in the drop test. The elongation for 0.45 per cent. carbon averaged about 27 per cent. and for 0.61 per cent. carbon about 17 per cent. Roughly, the elongation decreased 0.6 per cent. for each 0.01. per cent increase in carbon, between the above carbon limits.

Transverse tests of the base were made by supporting pieces of rail 2 ft. long, on two supports placed opposite each other near the edges of the flanges under the middle of the length of the piece tested. The supports were 6 in. long and were placed ½ in. in from the sides of the flanges. The load was applied in the test machine to the head of the rail at the middle. With the 0.61 per cent. carbon steel, treatment with 2 oz. of aluminum was attended with considerable increase in transverse strength and sag of flange before breaking. With treatments with 5 oz. and 10 oz. of aluminum per ton of steel, there were some further increases. With the 0.45 per cent. carbon steel, there were small increases in transverse strength and sag of flange with the aluminum treatments as against plain steel.

To sum up, ingots treated with aluminum as mold additions, were of more even composition throughout the ingot than plain Bessemer steel. There was less positive segregation in the interior and upper part of the ingot but the negative segregation or soft center in the interior and lower parts of the ingot was about the same. There was a softening or negative segregation in the upper part of the wall of the plain ingot while in the aluminum treated ingots, the walls were of fairly even composition throughout the height of the ingot. Aluminum treated ingots had larger and deeper pipes than plain steel but had denser steel around the pipes. Rails of plain steel had a brittle zone in the upper part of the bar as disclosed by the drop test. In the rails of aluminum treated steel this zone was largely eliminated. Rails of plain steel contained their laminations close to the top end of the bar, while in aluminum treated rails, the interior laminations were found a considerable distance from the top end, varying from about 30 to 45 per cent. of the weight of the ingot. In the transverse test of the base, rails of aluminum treated steel showed considerably greater transverse strength of the base and sag of the flange before breaking, than the rails of plain steel, with 0.61 per cent. carbon and a little greater strength and sag of flange with 0.45 per cent. carbon.

Discussion on Rail.

J. A. Atwood, chairman, outlined the subjects assigned to the committee for report.

E. Trimble: I would say that the committee on standard rail sections has been embarrassed a little by the instructions that it has received. Several years ago the American Railway Association evolved two sets of sections called Series A and Series B, which were referred to this Association to recommend one section for the use of the railroads. There are only a few people who have gone to the trouble of making comparisons between these two sections. We find in looking over the statistics in response to the inquiries sent out by the committee that a great many of the roads which use the old American Society of Civil Engineers section are entirely satisfied with that section and they do not want to make any change. We find a

tendency by some to develop new sections varying from the sections now in existence. I think I voice the sentiment of this entire committee, when I say that we believe it will be a mistake for any of the members of this Association to design a new section which varied by the very smallest fraction of an inch from the sections we now have. If different members of the Association go ahead multiplying their sections without regard to the work of this Association, this matter of the rail sections is going to get into the same chaotic condition that it was in before the American Society of Civil Engineers sections were evolved.

J. L. Campbell (E. P. S. W.): I would ask if the committee considered the practicability of having one width of rail base to include several weights of rails, especially from 85 lb. up.

W. B. Storey (Santa Fe): The remarks of the chairman of the subcommittee, Mr. Trimble, seem to be directed against the Santa Fe system, as we change the A. R. A. section $\frac{1}{16}$ in. It was due to the fact that we had an 85 lb. rail for which we provided tie plates over the entire mileage where we use the 85 lb. rail, and when we change to the 90 lb. rail, we change the A. R. A. section so as to make it the same base as we had it before, and we were able to use the same tie plates we had for the 85 lb. rail.

Mr. Atwood: The matter under the heading, "Statistics of Rail Failures," is offered as information.

W. H. Courtney (L. & N.): I would like to secure some statistics from the various railroads regarding rail failures due to transverse fissures. In the course of my experience on railroads I have seen many different kinds of broken rails, but I never saw a rail that failed on account of transverse fissure until February, 1911. We all know that the engineer-physicist of the Interstate Commerce Commission, Mr. Howard, attributes the failure of rail due to this cause, to the simple reason that the rail is not strong enough. On the L. & N. road we have a 70 lb. rail rolled under the same general specifications, except that the carbon is lower than in the 80 lb. rail—rolled at the same mill, same time, and is same metal. We have never had a transverse fissure reported in the 70 lb. rail, although on some divisions we run the same weight of engine over the 70 lb. rail as we do over the 80 lb. rail. That appeals to me as a powerful argument against the theory of Mr. Howard that the rail is not strong enough. The rails with this defect snap quickly and there is no warning when they are about to break. Some times a minute crack on the side of the head of the rail is discovered by the presence of a slight amount of rust running down the side of the rail. I have had a number of rails broken which disclosed the fact that transverse fissures caused the rail to break, and then in taking the rail and breaking it clear through, we find absolutely gray material ranging in size from ⅜ in. in diameter to over half the area of the head.

Mr. Atwood: This is the subject before us which will be given serious consideration during the next year.

M. H. Wickhorst: On the matter of broken rails and broken bases I might state very briefly that the work done indicates that a seam in the base may be anywhere from a few hundredths to ⅛ in. or more in depth longitudinal to the rail, anywhere in the base. These seams also occur in other portions of the sections; but so far it does not appear that such seams cause rail failures. When they occur in the base, and particularly in the center of the base, running lengthwise under the web, or near that position, they are apt to be the origin of a broken rail. These seams start back with the ingot from which the rail was rolled. Transverse fissures have been a very puzzling proposition. We have given close attention to one rail and we find on examination that the interior of the head contained a great many fissures, not only transverse, but also longitudinal, oblique and in all directions; in other words, the whole steel was honeycombed with these transverse fissures.

(Mr. Atwood then read the conclusions and which were approved without discussion.)

Mr. Lindsay: The statistics of the rail failures on 1,300 miles of track on my division emphasizes to me in a peculiar way the effect of speed on rail failures. Tracks 1 and 2 were laid with 100 lb. rails, on stone ballast; tracks 3 and 4 were laid with mostly 80 lb. and 100 lb. rail, on gravel ballast, taken off tracks 1 and 2 in previous years. Out of 232 failures of 100 lb. rail, 176 were on the passenger tracks and about 24 on the two freight tracks. Speed must have some very great effect on the breakage of rails, more than we have perhaps given it credit for.

The Ohio & Pennsylvania Belt will soon ask for bids on three miles of line from Lowellville, Ohio, to Haselton. D. M. Wise, chief engineer, Youngstown, Ohio.

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Steinberger, M. F., Asst. Engr., B. & O. R. R., Baltimore, Md.
Stelle, C. A., Div. Engr., C. & A. Ry., Bloomington, Ill.
Stimson, Earl, Engr. M. W., B. & O. R. R., Baltimore, Md.
Stimson, F. J., Div. Engr., G. R. & I. R. R., Grand Rapids, Mich.
Stocker, J. A., Ch. Engr., Toledo & Ohio Cen. Ry., Columbus, O.
Stout, H. M., Record Engr., N. P. Ry., St. Paul, Minn.
Stuart, Francis Lee, Ch. Engr., B. & O. R. R., Baltimore, Md.
Taylor, Frank, R. W. & L. Agent, C. P. R., Montreal, Can.
Trabue, H. H., Asst. Ch. Engr., N. C. & St. L. Ry., Nashville, Tenn.
Tuthill, Job, Engr. Bldgs., K. C. T. Ry., Kansas City, Mo.
Vollintine, J. L., Chief Clerk Val., C. B. & Q. R. R., St. Louis, Mo.
West, O. J., Ch. Engr., Massey Co., Chicago, Ill.
Wharf, A. J., Chief Engr., P. & P. U., Peoria, Ill.
White, C. R., General Roadmaster, M. P. Ry., Wynne, Ark.
Wilkinson, J. W., Div. Engr., N. Y. C. & St. L. R. R., Cleveland, O.
Williams, W. D., Chief Engr., C. N. R. R., Van Wert, O.
Wonson, S. L., Asst. Bridge Engr., M. P. Ry., St. Louis, Mo.
Wurzer, E. C., Asst. Engr. on Con., M. C. R. R., Detroit, Mich.
Young, R. C., Chief Engr., L. S. & I. and Munising Rys., Marquette, Mich.

GUESTS.

Banker, J. H., Gen. Foreman B. & B., A. T. & S. F. Ry.
Batt, M. E., Roadmaster, L. & N. R. R., Pensacola, Fla.
Barnoske, F. M., Roadmaster, C. M. & St. P. Ry., Washington, Ia.
Barnhart, E. H., Asst. Div. Engr., B. & O. R. R., Baltimore, Md.
Beckwith F. L., Valuation Engr., G. T. Ry.
Black, R. H., Mech. Engr., G. T. Ry., Montreal, Que.
Blackie, Geo. F., Asst. Engr., N. C. & St. L. Ry., Nashville, Tenn.
Blackwell, N. T., Roadmaster, C. R. I. & P. Ry., Windsor, Mo.
Blinstengel, Asst. to Engr. Test, A. T. & S. F. Ry., Topeka, Kan.
Bowker, C. G., Gen. Supt., G. T. Ry., Montreal, Que.
Bowman, R. M., Asst. Engr., L. E. & W. R. R., Indianapolis, Ind.
Boyd, J., G. T. Ry., Hamilton, Ont.
Boyle, J. C., Office Engr., K. C. T. Ry. Co., Kansas City, Mo.
Bradley, A. C., Roadmaster, C. R. I. & P. Ry., Iowa City, Ia.
Broddle, Wm., Roadmaster, C. R. I. & P. Ry., Herington, Kan.
Brown, E. H., Asst. Engr., N. P. Ry., Fargo, N. D.
Bulkley, C. W., Draftsman, G. T. Ry., Montreal, Can.
Cameron, J. B., Div. Engr., B. & O. R. R., New Castle, Pa.
Carpenter, H. R., Engr. M. of W., M. P. Ry., St. Louis, Mo.
Carter, T. L., Jackson, Mich.
Chapman, E. E., Asst. Engr. Tests, A. T. & S. F. Ry., Topeka, Kan.
Chausse, W., Detroit, Mich.
Coe, Robert, Engr., Carnegie Steel Co., Pittsburgh, Pa.
Collins, L. W., Asst. in Test Dept., A. T. & S. F. Ry. Topeka, Kan.
Cross, Byron, A. T. & S. F. Ry., Arkansas City, Kan.
Cronkrite, A. C., Universal Portland Cement Co., Chicago, Ill.
Dee, Wm. V., Sales Mgr. and Secy., The G. Drouve Co., Bridgeport, Conn.
Deimer, Walter, H., Contractor, Hanly Grove, Tex.
Dinkley, Chas. E., Gen. Supt., Carnegie Steel Co., Braddock, Pa.
Dixon, J. H., Supt. of Creosoting, C. P. Ry., North Transcona, Man.
Dunlap, G. W., Ch. Clerk, Eng. Dept., G. N. Ry., St. Paul, Minn.
Fowler, T. E., Ch. Engr., Bartlett Western Ry., Bartlett, Tex.
Frailey, F. H., Asst. Engr., A. T. & S. F. Ry., Sibley, Mo.
Fuller, Fred C., Ch. Clerk, Test Dept., A. T. & S. F. Ry., Topeka, Kan.
Gibson, W. C., Sales Engr., Allis-Chalmers Co.
Gillen, W E., Gen. Supt., G. T. Ry., Chicago.
Goos, Julius H., Inspecting Engr., G. N. Ry., St. Paul, Minn.
Graham, F. N., C. G. W. R. R. Co., Chicago.
Grant, E. W., Asst. Engr., A. T. & S. F. Ry., Topeka, Kan.
Gray, E. P., Instr. Man, G. T. Ry., Detroit, Mich.
Grime, E. M., Supv. B. & B., N. P. Ry., Fargo, N. D.
Grow, J. H., Sales Engr., Allis-Chalmers Co., Milwaukee, Wis.
Hamilton, E. E., B. & O. R. R., Baltimore, Md.
Harmon, H. B., Transitman, A. T. & S. F. Ry., Arkansas City, Kan.
Harris, Geo. E., Carnegie Steel Co., Braddock, Pa.
Hatch, James N., Structural Engr., Chicago, Ill.
Hattery, Chas., Signal Supr., C. R. I. & P. Ry., Topeka, Kan.
Hoffmann, John H., Asst. Engr., C. R. I. & P. Ry., Chicago, Ill.
Houghton, Shirley, Engr., Van Zant-Houghton, San Francisco, Cal.
Hutchison, J. G., Roadmaster, C. R. I. & P. Ry., Clay Center, Kan.
Jackson, J. R., Asst. Engr. Tests, A. T. & S. F. Ry., Chicago, Ill.
Kelley, C., Roadmaster, A. T. & S. F. Ry., Guthrie, Okla.
Lehman, J. L. G., Asst. Engr., K. C. T. Ry. Co., Kansas City, Mo.
Madden, P. H., Roadmaster, C. M. & St. P. Ry., Sparta, Wis.
Mann, L. R., Supervisor of Signals, M. P. Ry., St. Louis, Mo.
McGuigan, J. S., Roadmaster, St. L. & S. F. R. R., St Louis, Mo.
McLeod, P. A., Asst. Engr., St. L. & S. F. R. R., St. Louis, Mo.
Metcalf, J. M., Div. Engr., M. K. & T. Ry., Parsons, Kan.
Moore, W. G., Asst. Engr., B. & O. R. R., Baltimore, Md.
Neiss, C. B., Instr. Man, G. T. Ry., Detroit, Mich.
Neptune, W. M., Asst. Engr., M. P. Ry., St. Louis, Mo.
Nyquist, A. W., Contractor, Naperville, Ill.
Orton, I. F., Interstate Chemical Co., Galveston, Tex.
Palmer, H. A., Asst. Engr., G. T. Ry., Toronto, Ont.
Park, F. L., Master Carp., C. R. I. & P. Ry., Topeka, Kan.
Pinkerton, C. M., C. R. I. & P. Ry., Chicago, Ill.
Pinson, J. F., Asst. Engr. B. & B., C. M. & St. P. Ry., Seattle, Wash.
Poronto, H. E., Vice-Pres., Chicago Junction Ry., Chicago, Ill.
Pugh, Geo. W., Ch. Clerk to Ch. Engr., G. T. Ry., Montreal, Que.
Quick, L. S., Div. Claim Agt., Erie R. R., Marion, O.
Ramsdell, A. B., Supt., C. R. I. & P. Ry., Herington, Kan.
Reaney, C. F., Asst. Engr., W. C. F. & N. Ry., Waterloo, Ia.
Rogers, E. O., Gen. Signal Insp., Erie R. R., Jersey City, N. J.
Rousseau, A. J., Asst. Engr., M. C. R. R., Dearborn, Mich.
Rutherford, F. A. Trainmaster, G. T. Ry., Battle Creek, Mich.
Safford, J. B., Supt., P. C. & Y. Ry., Pittsburgh, Pa.
Sears, John, Roadmaster, D. & I. R. R. R., Two Harbors, Minn.
Seely, S. A., N. Y. C. & H. R. R. R., Watertown, N. Y.
Shea, W., Roadmaster, C. M. & St. P. Ry., Ottumwa, Ia.
Shoemaker, R. J., A. T. & S. F. R. R., Topeka, Kan.
Siegner, W. C., Asst. Engr., G. T. Ry., Stratford, Ont.
Sills, J. M., Dist. Engr., St. L. & S. F. R. R., Springfield, Mo.
Skinner, C. J.
Smith, Hiram J., So. N. E. Ry., Palmer, Mass.
Smitzdorf, Ben. F., Asst. to Engr. Tests, A. T. & S. F. Ry., Chicago, Ill.
Steinmayer, O. C., Gen. Treating Insp., St. L. & S. F. R. R., Springfield, Mo.
Stone, L. S., Asst. Engr., G. T. Ry., London, Ont.
Sullivan, Chas. L., Chicago.
Tilley, C. M., Insp., Southern Ry., Washington, D. C.
Told, Arnold H., Res. Engr., C. P. Ry., Winnipeg, Man.
Walker, P. O., Roadmaster, A. T. & S. F. Ry., Guthrie, Okla.
Wait, B. A., Asst. Engr., C. R. I. & P. Ry., Des Moines, Ia.
Wheeler, F. S., Div. Engr., Erie R. R., Buffalo, N. Y.
Whittenberger, H. E., Gen. Supt., G. T. Ry., Toronto, Ont.
Wilson, Chas. L., C. N. Ontario Ry., Toronto, Ont.
Winchester, P. H., Div. Engr., N. Y. C. & H. R. R. R., Watertown, N. Y.
Woerner, Albert F., Asst. Div. Engr., B. & O. R. R., Philadelphia, Pa.

COMMITTEE ON STRESSES IN TRACK

The committee appointed some time ago by the Board of Direction to study stresses in track met yesterday noon and completed a preliminary organiaztion for the proposed work. They also arranged to collect all the available data on the subject before beginning actual original investigation.

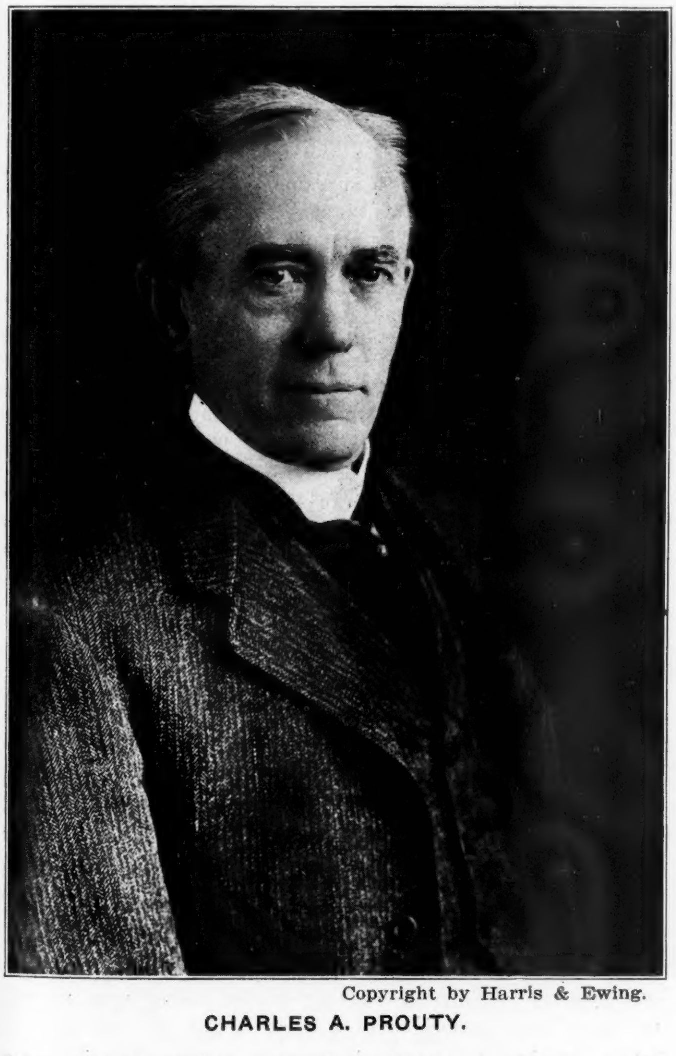
THE ANNUAL DINNER

The fifteenth annual dinner of the American Railway Engineering Association was given last night in the Gold room of the Congress hotel. The attendance was even larger and more representative of the membership of the organization than the very successful banquets which have accompanied the recent conventions. President Edwin F. Wendt was the toastmaster and the speakers were the Hon. Charles A. Prouty, director, Division of Valuation, Interstate Commerce Commission, the Hon. Charles Marcil, M. P., ex-speaker of the Canadian House of Commons, and J. M. Schoonmaker, vice-president of the Pittsburgh & Lake Erie.

The former two spoke at some length and Col. Schoonmaker made a few brief remarks. The entertainment committee deserves credit for the high quality of the musical program which was presented during the dinner. Abstracts of the addresses follow.

Charles A. Prouty.

In the last fifteen years the price of every article of universal and general consumption, with one exception, has advanced, and that exception is transportation by rail. If transportation by rail alone has not advanced it is because railway engineers, by providing a better way and a better machine to operate upon that way, have rendered it possible to make economies which have offset the increased cost of



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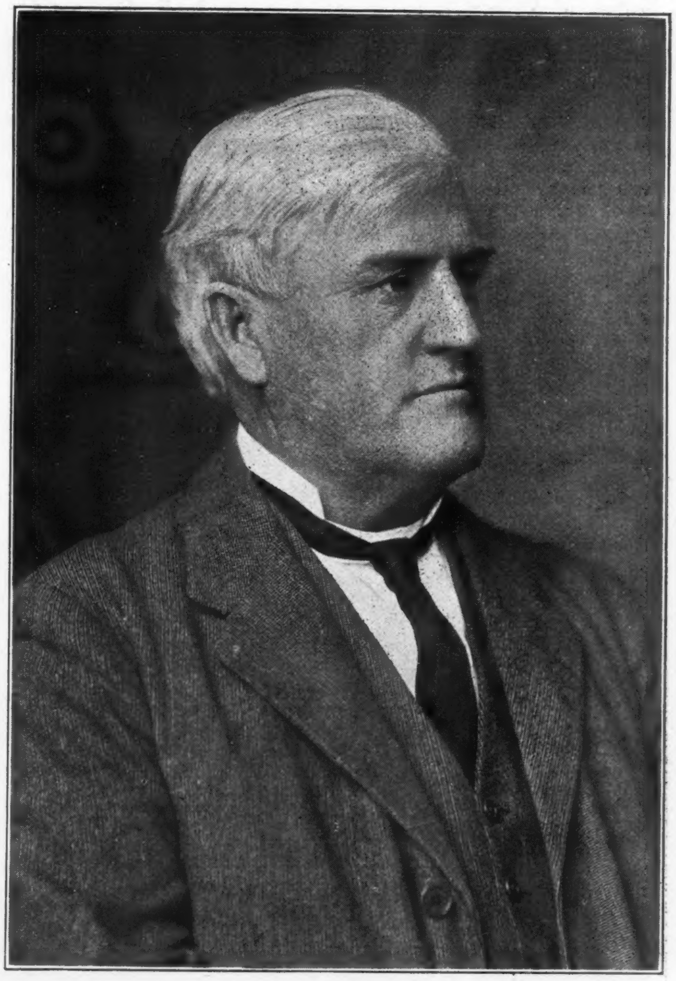
CHARLES A. PROUTY.

labor and of supplies. The United States is about to enter upon a work of very great consequence, and the railway engineers are identified with that work. The problem is not altogether an engineering problem. It smacks of economics and of law and of politics, but the business of ascertaining and collecting a great part of the information is peculiarly a task of the engineer's, and I am not certain but that the engineer may finally turn out to be the best qualified of all to consider the other problems.

Now, when I began this work I was told that an engineer could measure and figure with accuracy, but that he was not competent to discuss the intricate problems presented by the valuation of our railroads, and that we must be very careful not to let him undertake to discuss them. I am fast coming to the conclusion that he may be better qualified than anybody else to discuss them. I have been a law-



HON. CHARLES MARCIL.

yer all my life and I believe that my profession is the greatest of all professions, but I am obliged to admit, and I think I have said this before, that the training of a lawyer does not fit him for the discussion of questions of this kind. A lawyer by his training is a partisan. If you go back to the law school you will find that he is given a certain thing to affirm, and it is his business to make out that case. In life he has one side of a controversy, and he must establish that his side is right.

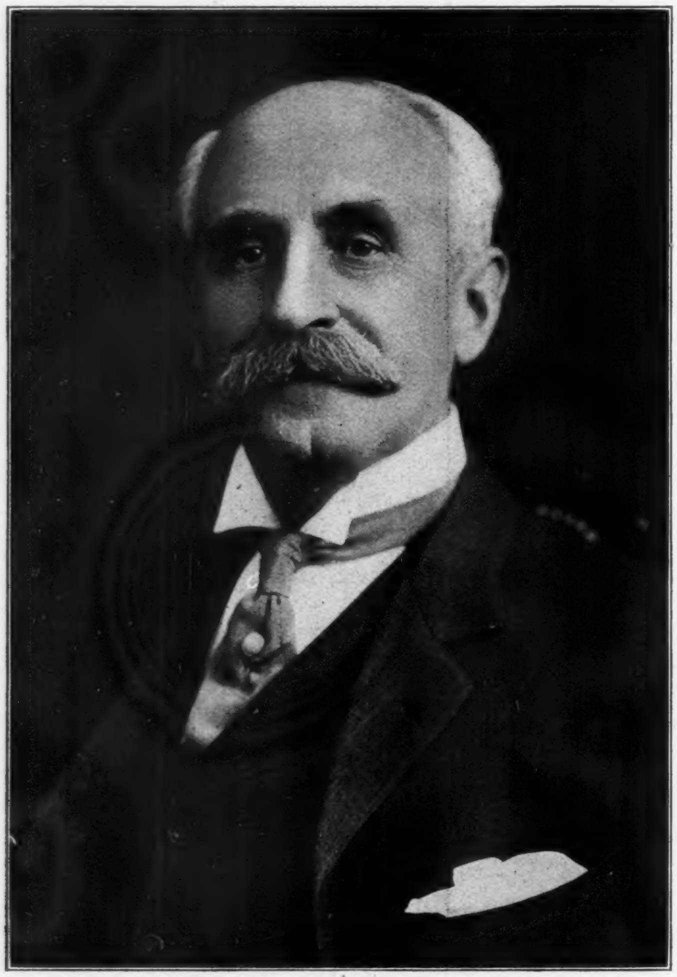
The engineer is entirely different. He begins in school with mathematics. There is but one answer to a problem in mathematics. It may be hard work to find it, but there never can be two answers. When the engineer gets into life it is still his business to find the fact, and just according as he can find the fact and be certain of the fact, he grows. If an engineer designs a bridge, and that bridge falls, his reputation falls with it. He cannot call in the undertaker and bury his blunder, as the doctor does. He can't charge it to the stupidity of a court, as the lawyer does. He must assume the burden of it himself. So I say that the very training of the engineer fits him for that precise kind of thinking which is essential in the working out of these new problems where absolute impartiality is necessary.

Charles Marcil.

In Canada we have had to deal with the railway problem, but we are merely undertaking the work which has been so far advanced in the United States. The United States is a land of railways. Without railways the United States would have practically no existence. It would be still worse in our country if we had no railways, but the railways we have in Canada have been built practically within one generation. We have many men who remember the first rail-

way, covering 18 miles, built from the banks of the St. Lawrence towards the town of St. Johns. That roadbed is still there. In 1836 Canada had 18 miles of railway, and the record tells us that Lord Gossard, who was Governor General of Canada, inaugurated that road.

I came here to attend this meeting to show the good feeling we have in Canada toward your organization, because you have in your membership 100 of the sterling men of Canada, men who do our daily work. Before coming here I asked a high official in Canada, the deputy minister of railways and canals, to give me some word as to the standing of the American Railway Engineering Association, and these are the words he wrote me: "In connection with the safe and economic operation of a railway, so much depends upon the condition of the track and roadbed that the American Railway Engineering Association is possibly the most important aid to railway organization, and its work and influence have been so effective that standards not approved by that Association are not recognized while, on the other hand, their



J. M. SCHOONMAKER.

annual reports form text books on maintenance of way in American railway practice."

We have not in Canada the numerous obstacles that you have to overcome in the United States regarding the operation and construction of railways. All of our railways are under federal control. Our constitution was framed in 1866, became effective in 1867, and we, of course, borrowed your experience. Though we have a modified system of state's rights in the provinces, we conceded from the start that the railways should be under the control of the federal authorities and these federal authorities have created a commission, which has done a most effective work during the last ten years. It has done away with the impression which existed in the public mind at that time that the railways were all powerful, that they could monopolize the election of members to the House of Commons, that they could control the voice of the legislative assemblies, that by accumulating capital and by election subscriptions they practically managed and owned the country.

Engineers in the United States are familiar with our railways, but I wish to say a word about the old Grand Trunk Railway. To-day the Grand Trunk is being extended, its mileage doubled. Its mileage at the end of the present year will consist of at least 10,000 miles. A new addition has been added under the name of Grand Trunk Pacific. Canada up to fifteen years ago was a mere fringe upon the border of the United States. The people inhabiting our territory lived mostly along the borders of the St. Lawrence, along the borders of the Great Lakes, and along the American frontier through the provinces of the West. When Sir Wilfrid Laurier reached power in Ottawa, and the new era set in in Canada, we felt that Canada had to be given more depth, that there lay to the north of old Canada an immense territory which had to be opened up. We do not boast of the extent of our territory, but the geographical conditions are there, and we are proud to be able to tell our children in our schools that our territory, for whatever it is worth, is larger than yours.

Our western country would never have had any existence but for the railways, and to-day we feel the benefit of them. We are building the Grand Trunk Pacific to Prince Rupert bay, by which we will shorten the journey to Japan and China by one week. We are building the Hudson Bay railway, which will open up a new outlet, and which will bring the city of Winnipeg 1,000 miles nearer to Liverpool.

J. M. Schoonmaker.

I take my hat off in profound respect to the railroad engineers of to-day, and I want to pay them this tribute, that I do not think any man in the service of the transportation interests of this country has a less enviable task than the railroad engineer, for his work is never done. The work he has done with such credit to himself was splendid perhaps ten years ago, but is obsolete to-day, and the work he does to-day will be obsolete ten years from to-day. His task is endless, and they meet with emergencies from time to time, from a strictly commercial standpoint, in making requisition for more funds and the rest of us have to get the money.

COLONEL PROUT PROMOTED

Colonel H. G. Prout, vice-president and general manager of the Union Switch & Signal Company, was yesterday elected president of that company. Colonel Prout was formerly editor of the Railroad Gazette and in 1903 went with the above-mentioned company as its general manager.

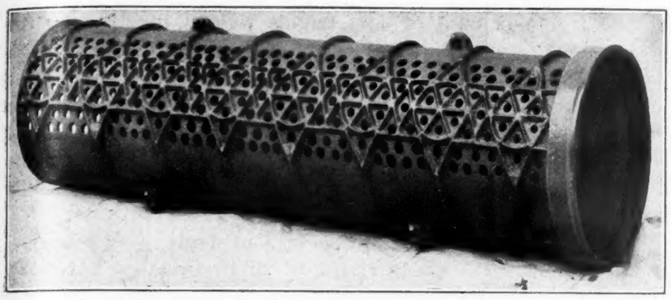
WITH REFERENCE TO PHOTOGRAPHS

The *Railway Age Gazette* has for some time had in effect arrangements made with two Chicago photographers for the purpose of obtaining portraits to be published in its columns as need for them might arise. Owing to developments during the last week, which have caused annoyance to some railway men attending the conventions, these arrangements have been cancelled, and no photographer in Chicago now has any right to solicit any person to have a photograph taken for this paper unless specific authority to do so is given in writing by some person regularly employed by the *Railway Age Gazette*.

NEW TYPE OF CAST IRON DRAIN PIPE

A cast-iron sectional perforated culvert pipe has just been placed on the market, and has been specified by two trunk line railways in the East for spring delivery. It is particularly adapted for draining the subgrade along water tanks, in deep cuts or at any point where the natural drainage is imperfect. This pipe is made from the best grade of foundry gray iron pig, and is cast in horizontal flasks, resulting in a uniform thickness of metal for the entire length of the pipe. The pipe is cast in two sections, which, after cleaning, are bolted together with ½-in by 2½-in. bolts and placed in a heating retort at 750 deg. F. From this heating retort the pipe is taken while hot to a tank, where it is immersed in a bath of asphaltum and coal iron. The pipe is of the bell and spigot style, and is made in diameters of 8 in., 10 in. and 12 in. At present the 4-ft. length is the only one made. The perforations in the upper section of the pipe, unless specially ordered, are ½ in. in external diameter and ⅞ in. in internal diameter, in order to eliminate the danger of having the perforations

stopped up. Any substance entering the pipe will naturally fall to the bottom of the pipe, and if the water head is not sufficient to remove any such accumulation the pipe can easily be cleaned by removing the ballast, releasing

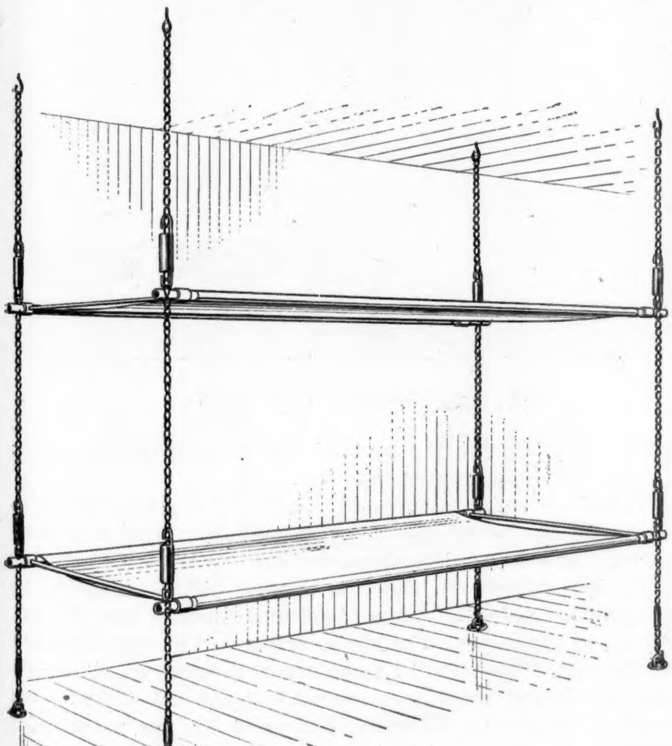


Perforated Cast-Iron Culvert Pipe.

the connecting bolts and removing the top section of the pipe. This pipe is manufactured by the Galion Iron Works & Manufacturing Company, Galion, O.

THE COMFORT DETACHABLE SPRING BED

A spring bed has recently been put on the market which is particularly adapted to use in bunk cars, hospital cars and for emergency use in freight train cabooses and baggage cars. It consists of four chains hooked to the ceiling and floor of the car and supporting at proper intervals sections of steel tubing between which are stretched strips of canvas forming two beds. The canvas is looped over the tubing at each side and sewed, spacer bars being provided at each end of the tube to maintain the proper width. Helical springs are inserted in the chains just above the point of connection of each



The Comfort Spring Bed.

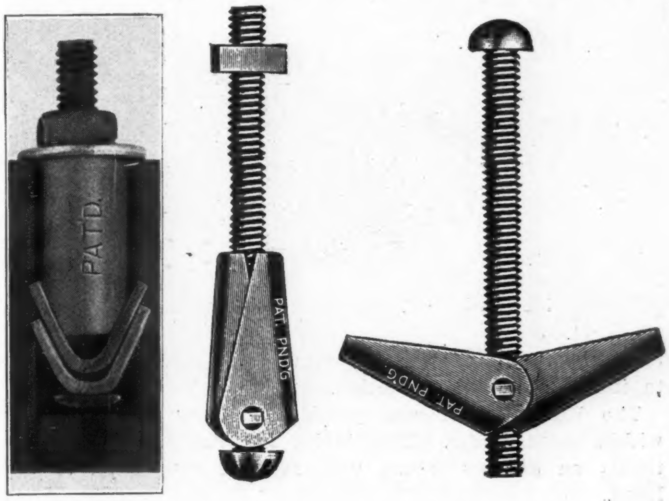
of the beds and a third spring is provided in each chain near the floor which must be expanded 1½ in. to allow the chain to be unhooked. As this requires a bar or lever, it is improbable that the bed will be carried off and at the same time the attendant can remove the beds easily for cleaning or renewal. The springs at each bed can be hooked up if it is desired to elevate the head of the bed.

These beds have been used in the municipal lodging house, Chicago; in a hospital car built for the Illinois Central and in a similar car used on the Rock Island track elevation work in Chicago, which was described in the RAILWAY AGE GAZETTE of October 24, 1913. In addition to their convenience, they are usually sanitary for bunk car service, as no mattresses are required. The bed can also be installed at a lower cost than the ordinary steel bunks, as they can be supplied in quantities for $10.50 each, or $84 for a car with 16 bunks. The chains and tubing are galvanized and the canvas when spread is 6 ft. 2 in. long by 30 in. wide. It is esteemed that this canvas will have a life of five years.

The beds are made by the Comfort Spring Cot Company, Chicago.

THE PAINE EXPANSION SHELL AND TOGGLE BOLT

The Paine Company, Chicago, has developed a new type of toggle bolt for building construction work and a new expansion shell for attaching fixtures to concrete, marble, slate, tile, etc. The toggle bolt head is made in two parts, which are connected over a trunnion, screwing on the bolt. A small spring holds these two parts in the open



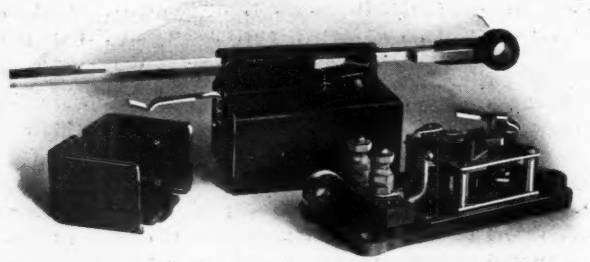
Expansion Shell. Toggle Bolt—Open and Closed.

position, but to insert the bolt the parts can be pulled together, allowing the bolt to pass through a 9-16-in. hole. As the head is only one in. long when closed, the bolt can be used in a hollow tile, which allows only 1⅛-in. space for the bolt to open. When the two halves of the head are spread out they cover a width of about two ins. The two halves of the head engage the thread of the bolt, giving additional holding power to the nut. This bolt can be used either with a nut or as a screw.

Three types of expansion shells are manufactured, allowing a wide range of adaptation. These shells consist essentially of a sleeve over the bolt, one end of which is tapered, fitting into a cup, which is expanded as the nut is turned down on the sleeve, forcing its tapered end into the open end of the cup. To use the shell a hole is bored, the bolt, sleeve and cup, assembled, are dropped into the hole, and the nut is screwed down. In the case of very soft material, or of an extra large hole, two of the cups are used on each bolt to give additional holding power. The cups are made of sheet steel cut with dies that leave the lip of the cup square and sharp. These shells are made to fit all standard bolts and screws.

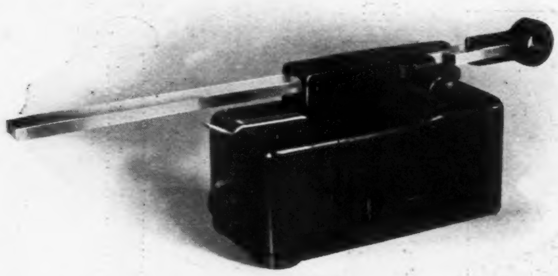
A NEW TIME RELEASE

A new mechanical time release has recently been placed on the market by the Hall Switch and Signal Company. This device, shown in the accompanying illustration, is applied to signal levers equipped with half reverse locks,



Parts of the New Hall Time Release.

and is used to introduce a time element between the placing of a signal normal and any change in route for which the signal was reversed. The device makes a satisfactory substitute for approach locking on levers which control dwarf signals and "calling on" arms—in which case an



Mechanical Time Release Assembled.

interval of from 5 to 15 seconds is considered sufficient to insure adequate protection.

The Hall time release provides for any specified time within these limits. The device is usually mounted vertically on gallows frame, with straight connection to tail lever.

NEW FREE-ENGINE MOTOR CAR

A new design of Rockford motor car has recently been placed on the market by the Chicago Pneumatic Tool Company, Chicago. In contrast to the direct connected type

New Rockford Motor Car.

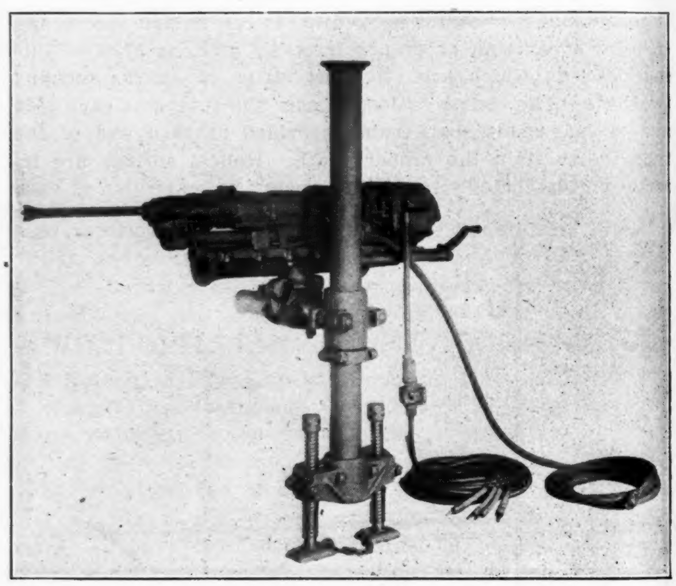
which this company already makes, the new car will have a free engine, which has the advantage of being able to start regardless of ice, snow or load. The maximum speed can be fixed at any point between 3 and 18 miles per hour.

The frame is built of 3-in. angles welded together by the autogenous process. Steel wheels 16-in. in diameter with standard M. C. B. flanges are used. The motor is of the reversible two-cycle type, hopper cooled, and develops four horsepower. The gasoline is carried in a 1½-gal. tank of 20-gage galvanized steel, which is mounted on the engine and is not fastened to the frame of the car. One filling of the tank is said to operate the car about 30 miles.

This car will carry eight men and tools under normal conditions at an average speed of 15 to 18 miles per hour. The weight is so distributed that it is possible for one man to handle the car under favorable conditions.

THE PNEUMELECTRIC ROCK DRILL

The Pneumelectric rock drill uses electricity as a motive power, but the blow is struck by compressed air. The electric motor is used for compressing the air, turning the steel and operating the small pumps for supplying water to the steel, This drill is of the hammer type, in which the steel is



The Pneumelectric Rock Drill.

kept in contact with the material that is being drilled and is struck by a reciprocating hammer.

The air is compressed in a cylinder by a piston which is driven by the motor, the motor and cylinder being a part of the drill and mounted on the same base. In the same cylinder with the motor-driven piston is another piston connected to the hammer and free from mechanical connection with the one driven by the motor. The air is compressed on the backward stroke of the piston until ports are uncovered which permit the compressed air to pass over the piston and expand. On account of the partial vacuum created by the withdrawal of the motor-driven piston, the piston carrying the hammer is drawn back at the same time until it is acted upon by the compressed air passing from behind the motor-driven piston. The hammer is thus operated by expanding air the same as in the compressed air drill.

The steel is intermittently rotated by the motor, power being transmitted through gearing and a ratchet and pawl. The chuck is designed to take any steel as it comes in the bar without shanking. A hollow steel is used so that water may

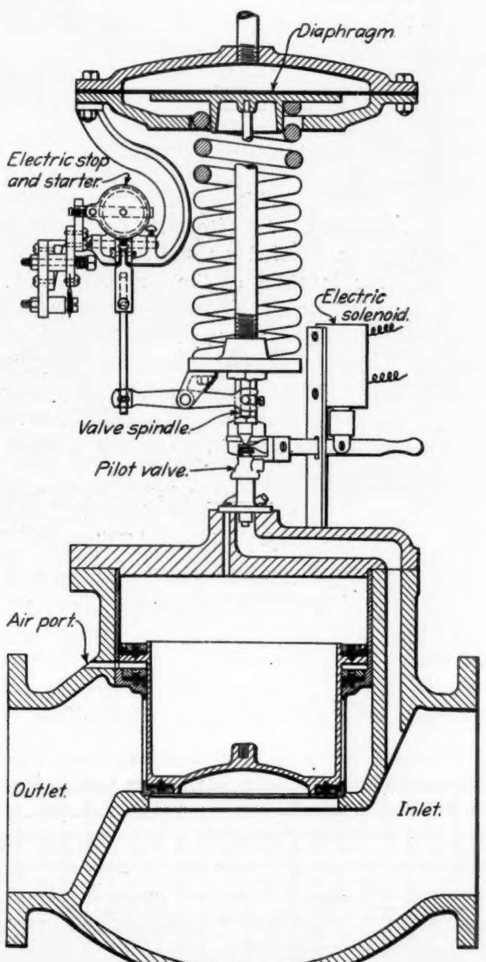
be introduced through it to the cutting face. This water removes the cutting from the bottom of the hole and lays any dust which might rise. The water can be supplied by a small motor-driven pump mounted on the drill or by a regular water system.

The motor used with the 2½-in. by 4½-in. drill has a capacity of 2¼ h.p. and can be wired for direct current or three-phase alternating current. This drill is particularly adapted to tunneling and shaft-sinking work and resembles closely in size and dimensions a 3¼-in. steam or compressed air drill. This drill is manufactured by the Pneumelectric Machine Co., Syracuse, N. Y.

IMPROVED ALTITUDE CONTROLLING VALVE

The automatic valve for controlling the water level in service tanks, standpipes and reservoirs, which is manufactured by the Golden-Anderson Valve Specialty Company, Pittsburgh, Pa., has been improved recently by the addition of an electric stop and starter attachment and an electric operating solenoid. The construction of this valve was described in the Railway Age Gazette of March 21, 1913, page 736.

The electric stop and starter attachment is used to cut in and out motor-driven pumps, signal bells, etc., automatically when the valve is operated. The method of accomplishing this is shown in the accompanying illustration. When the valve spindle raises in opening the main valve it pulls down a rod on the opposite end of a lever attached to the spindle. This rod controls the position of a hollow cylinder containing a heavy ball, which rolls to the low end of the cylinder when the main valve is open and closes the circuit which operates the pump, bells, etc. When the main valve is closed the downward movement of the spindle tilts the cylinder into the opposite position, causing the ball to roll to the other end and break the electrical circuit.



Automatic Controlling Valve with Electric Stop and Starter and Operating Solenoid.

In order to allow the valve to be closed from distant points an electric solenoid with lever attachment extending under the valve spindle has also been added, as shown on the drawing. This device is particularly useful in preventing the overflowing of the tank when the pressure in the main is increased in case of fire or other cause.

A NEW HAND MIXER

A light portable hand mixer adapted to use in placing pedestals, platforms, foundations and culverts, has recently been placed on the market by the Northfield Iron Company, Northfield, Minn. Two types of this machine are built, one for slush mixing and one for dry or wet mixing. The two types differ only slightly in the mixing device and in the heads of the drum. The slush mixer has a capacity of about 4 cu. ft. and the dry mixer about 2½ to 3 cu. ft. Both are light enough to be moved easily by three men.

The Northfield Hand Mixer Placing a Concrete Floor.

The concrete is mixed in a drum 20 in. in diameter and 30 in. long mounted on a timber frame, the extreme height of the machine being 5 ft. This drum can be revolved through 180 deg. so that the same opening is used for charging and discharging. The charging spout is 30 in. wide at the opening, the top line of the chute being 3½ ft. above the ground, which is convenient for dumping from wheelbarrows when they are wheeled up a running plank placed on the top cross bar of the frame just beneath the crank shaft. The discharge spout tapers down to a 10-in. opening, making it possible to dump into wheelbarrows, narrow forms, conveyors, spouts or pails. The bottom point of the spout in the discharge position is 21 in. above the ground.

The mixing is accomplished by heavy wrought steel mixing blades bolted to steel mixing bars which in turn are bolted adjustably to metal spiders. The entire mixing unit is revolved in the batch by hand operated cranks at the ends of the drum, the gearing ratio being 4:1. It has been found that an ordinary crew of workmen will turn the crank on this mixer a little faster than one turn per second. As not over 30 turns are required to mix a batch of concrete thoroughly and the machine can be charged in 15 to 20 seconds, dis-

charged in three to five seconds and the drum righted again in about the same time, the average output of the machine can be made as high as one batch per minute under good conditions. At this rate the daily output would average 50 to 60 yds. The machine can be operated with a crew of two to five men depending on the method of charging. The best results can be obtained by charging with wheelbarrows and having one of the crank men apply the water and the other the cement. The men who operate the crank can also attend to the dumping.

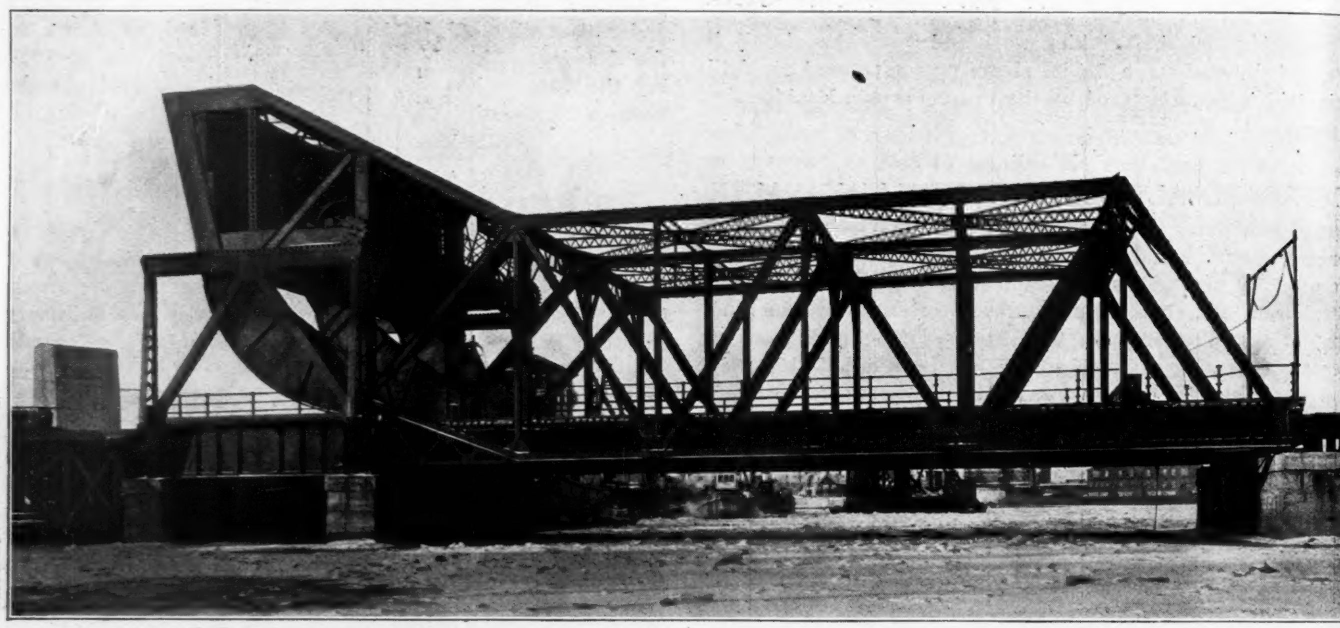
The mixer can be fitted with extra shafting, gears and belt pulley for operation by gasoline engine or electric motor if desired.

THREE-TRUSS SCHERZER ROLLING LIFT BRIDGES

A three-truss Scherzer rolling lift bridge carrying a double-track railway and a highway with a double-track electric line has recently been completed across the McKellar river at Fort William, Ont., for the Canadian Pacific. A similar but heavier bridge is now under construction for the Great Central Railway of England across the Trent river at Keadby, England. The Canadian Pacific bridge has a movable span 120 ft. long center to center of bearings, and a total width between outside trusses of 58 ft. The bridge is operated by electricity, with a provision for hand operation in case of emergency. This bridge was built under the direction of P. B. Motley, engineer of bridges, Canadian Pacific, and the superstructure was manufactured and erected by the Canada Foundry Company, Ltd., Toronto.

The Great Central bridge crosses the Trent river near its confluence with the river Humber, where the river traffic is very heavy. The structure will be composed of two fixed approach spans, in addition to the bascule span and the track girder span, upon which the moving leaf rolls. The total length of the bridge will be nearly 500 ft. Each span will have three trusses, the center truss dividing the 29-ft. railway section from the 24-ft. highway. The movable span is 160 ft. long and has an extreme width of 60 ft. The substructure consists of steel caissons, carried down about 50 ft. below low water.

The machinery and power equipment are designed to open and close the bridge in one minute. The electric power used will be generated in a machinery house alongside the bridge. The operating motor will be placed on the rear end of the movable leaf and geared to the main operating shaft, which drives pinions engaging with rocks on independent fixed supports outside of the plane of the movable bridge trusses. This method of operation is one of the special features of the latest Scherzer designs.

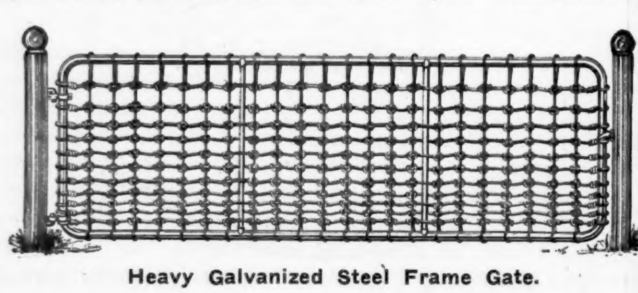


Canadian Pacific Bridge Over McKellar River at Ft. William, Ont.

This work will be carried on under the supervision of J. B. Ball, engineer in chief of the Great Central Railway, by whom the foundations and approach spans were designed. The designs for the moving span of both the Canadian Pacific and the Great Central bridges were prepared by the Scherzer Rolling Lift Bridge Company, Chicago, and a general consulting engineering supervision was maintained over the manufacture and erection of the bridges by that company.

A NEW STEEL GATE

An extra heavy galvanized steel gate has just been developed by the Peerless Wire Fence Company, Adrian, Mich. The frame is of high carbon tubular steel, electrically welded at all joints and galvanized throughout. The filling is made of No. 9 machine-woven wire close spaced between both line and cross wires. The cross bars are 6 in. apart, and the line wires have a minimum spacing at the bottom of the gate of 3 in. This gate differs from similar steel gates using No. 9 filler in that every wire extends beyond the fabric and is securely tied around the frame. All of the fittings are made from steel stampings instead of from malleable castings, and all of them are galvanized.



Heavy Galvanized Steel Frame Gate.

THE PREST-O-FLARE

The Prest-O-Flare is a portable outdoor light using acetylene as an illuminant, designed especially for the use of railways and contractors in tunneling, dredging, clearing up wrecks and emergency night work of all classes. The lamp has a polished alumnium reflector 15 in. in diameter mounted on a light adjustable iron tripod. The acetylene gas is secured from Prest-O-Lite seamless steel cylinders, which contain pure, dry acetylene. An automatic reducing valve is used which allows the acetylene to be turned on and off like a gas jet. This valve automatically prevents the pressure in the pipe line from exceeding the proper amount which is sufficient for obtaining the maximum flame at the burner. The flame can be turned down if desired, but it cannot be turned too high.

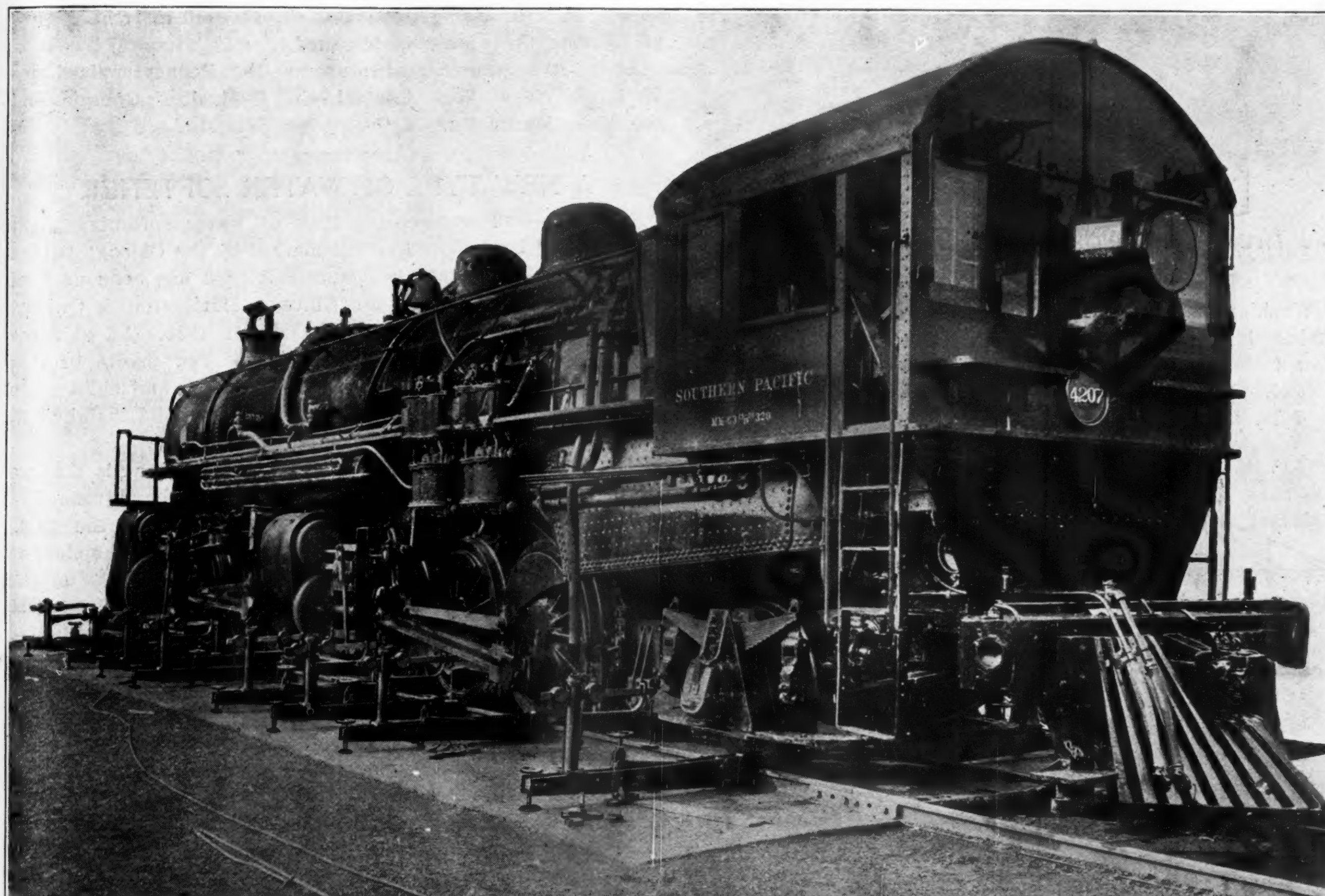
The lamp and standard may be carried easily to any desired location and when the work is scattered over a large area, the cylinders may be set in one spot and the lamps moved around over the work if a long hose is provided. When used on a traveling crane or steam shovel, the cylinders can be left on the machine and the lamp fastened on the derrick arm, where the light can be focused on the work. The light is manufactured by the Prest-O-Lite Company, Indianapolis.

THE STANDARD LOCOMOTIVE SCALE

A new type of locomotive scale, designed to give the weight on each wheel instead of each axle, has recently been placed on the market by the Standard Scale & Supply Company, Pittsburgh, Pa., and is now being used by the Baldwin Locomotive Works; the Atchison, Topeka & Santa Fe, and other railways. It is particularly adapted to secure the actual bearing weight of the locomotive on the wheels, which is important in securing the proper spring adjustment and in testing the distribution of pressure on the roadbed and structures.

No special foundation or fixtures are required for this scale, allowing it to be used either on the road or in the shop. It requires one scale for each locomotive wheel, as shown in the accompanying illustration. The main lever projects beyond the frame a sufficient distance to engage the locomotive wheel, the frame bearing on the base of the rail during weighing. It is essential that the roadbed be solid, and it is preferable to have a concrete base filling between the ties up to the base of rail.

The scale levers are of forged steel, and the weighing beam is graduated from 5,000 to 10,000 lb. in 50-lb. divisions. Weights are piled on the end of the beam for additional capacity. Each scale weighs approximately 450 lb. and is constructed for use on 80, 90 or 100 lb. rails. In weighing a locomotive the extreme end of the main lever is placed in its lowest position by operating the hand wheel under the weighing lever, the frame is placed upon the rail and leveled by the other hand wheel, to make the column plumb. To lift the locomotive wheel, the hand wheel under the beam is turned down until the weighing beam is balanced with the poise at the 5,000-lb. mark. The hand wheel develops 5,000 lbs. pressure against the locomotive wheel in balancing the scale, so that loads less than 5,000 lb. cannot be read. When all of the wheels are raised a metal strip ¼ in. thick should be passed between the top of the rail and the tread of the wheel, and a strip ⅛ in. thick between the gage of the rail and the flange of the wheel, in order to eliminate the possibility of friction preventing the free movement of the weighing beam.

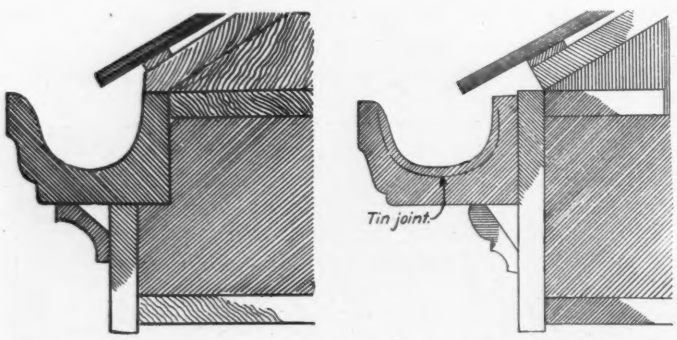


Standard Scales in Use for Determining Locomotive Wheel Loads.

IMPROVED O. G. FIR GUTTERS

While wooden gutters were generally used originally, they have been replaced very largely by copper, galvanized iron and other metal gutters in recent years on account of the increase in the cost of white pine, which was largely used in the manufacture of the wooden type. The proper manufacture and application of gutters made of Douglas fir has recently caused the adoption of this material by a number of railroads and contractors for building work.

The gutters manufactured by E. M. Long & Sons, Cadiz, O., are made from upland Douglas fir, found in the state of Washington. Only the butt of the tree is used, and the lumber is specially graded, both after it is sawed and after it leaves the machine in which it is plowed out and molded. The sizes used in railroad work are usually 5 in. by 7 in. and 4 in. by 6 in., although a 3-in. by 5-in. size is also standard. The gutters are carried in lengths from 10 ft. to 40 ft., and special orders are filled for each individual building.



Two Methods of Applying Fir Gutters, the First to New Buildings, the Second to Old.

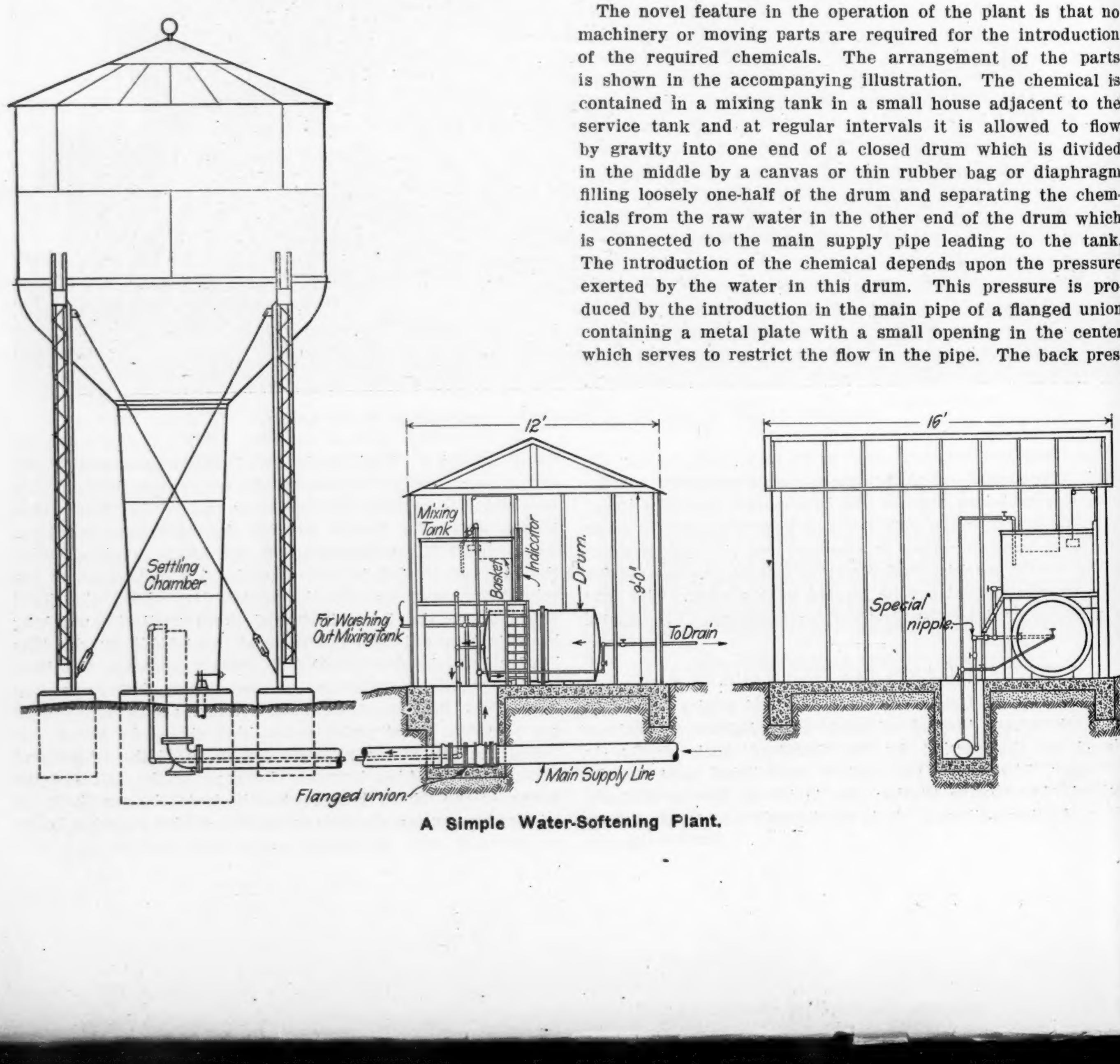
The advantages claimed for these gutters for railroad work are principally strength, durability and cheapness. When properly applied it is said that they will stand more abuse without damage than any form of metal, resisting the effect of snow slides, broken slate, brick from chimneys and scaffolding on the roof. A life of 25 years is claimed for these gutters without treatment, and considerably more than that if one of the reliable creosote treatments is used. These gutters are not subject to the deterioration of fumes and gases more or less common around railroad structures. The price of these gutters is less than copper or the best tin. They can be applied to a building by carpenters, and it is recommended that good-sized wood screws be used for fastening them in place, rather than nails or spikes, as a firmer fastening can be secured and the chance of injuring the gutter is lessened.

These five gutters are in use on the Pennsylvania Lines West, the New York Central, the Central of Georgia and the Pere Marquette.

A NEW TYPE OF WATER SOFTENER

A simple and inexpensive type of water softening plant has recently been placed on the market by the Chicago Bridge & Iron Works, Chicago, although this type has been used at eight different points on the Chicago, Burlington & Quincy, where the first installation was made in 1908. All of these plants are giving satisfactory service. Ten plants of this type have also been installed on the Wabash and eight more are now under construction. The plants can be installed at a cost not exceeding $1,200 complete.

The novel feature in the operation of the plant is that no machinery or moving parts are required for the introduction of the required chemicals. The arrangement of the parts is shown in the accompanying illustration. The chemical is contained in a mixing tank in a small house adjacent to the service tank and at regular intervals it is allowed to flow by gravity into one end of a closed drum which is divided in the middle by a canvas or thin rubber bag or diaphragm filling loosely one-half of the drum and separating the chemicals from the raw water in the other end of the drum which is connected to the main supply pipe leading to the tank. The introduction of the chemical depends upon the pressure exerted by the water in this drum. This pressure is produced by the introduction in the main pipe of a flanged union containing a metal plate with a small opening in the center which serves to restrict the flow in the pipe. The back pres-



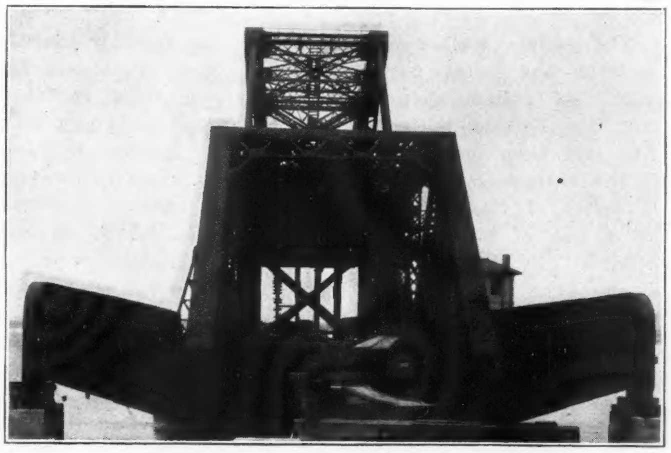
A Simple Water-Softening Plant.

sure so produced is proportional to the flow of water in the pipe. For the normal flow the hole is made of such a size as to cause a back pressure of about three lb. per sq. in. This pressure transmitted to the water end of the drum through a 1½ in. pipe, forces the diaphragm toward the chemical end of the drum and pushes out a small amount of the chemical through a 1½ in. pipe leading to the tank. The discharge end of this chemical pipe is turned at right angles across the end of the water inlet causing the chemical to be mixed thoroughly with the raw water as it enters the tank. The rate of flow of the chemical solution is controlled by a constriction in the line leading from the drum. By properly proportioning the sizes of the holes in the constriction plates in the main supply line and the chemical line, the relation of the amount of chemical to the amount of water can be accurately controlled.

The drum is designed to hold enough chemical to operate at least 24 hours. The operation of recharging the drum requires about 20 minutes. First the water that has accumulated in the drum during the day's run is discharged to a sewer, by closing the valves in the pipe line between the water end of the drum and the main line and in the line between the chemical end of the drum and the service tank, and opening the valves in the line leading from the mixing tank to the drum and from the water end of the drum to the sewer. The solution flows into the chemical end of the drum forcing the water out to the sewer. A float is provided in the mixing tank to indicate the amount of chemical used and in recharging, the proper amount of chemical can be added when the tank is refilled with water. Any desired combination of chemicals can be used with this system. The tanks are located in a house 12 ft. by 16 ft., which is heated with a small stove to prevent the freezing of water in the pipes during severely cold weather.

FOUR TRACK BASCULE BRIDGE

The first four-track bascule bridge ever built has just been completed by the Lake Shore & Michigan Southern over the Portage river near Port Clinton, Ohio. It consists of a standard double-track bascle bridge of the Strauss heel trunnion type, to which two tracks have been added outside the main trusses. These tracks are carried by short floor beams framing at one end into the main truss and at the other end into a plate girder with a pivot at one end concentric with the main trunnion. When the bridge is closed these two plate girders rest on the tops of the two channel piers and there are therefore no excessive deflections under live load, and only when the bridge goes up do the short outside floor beams act as cantilever brackets, which in turn support and lift the plate girder.



End View of Four-Track Bascule Bridge.

The length of the main span is 118 ft. and of the tower span 40 ft. The bridge is operated by two 75 h. p. direct current motors and there are also two lock motors for the end locks of the bridge and four rail lock motors for the operation of the company's standard rail locks.

The bridge was designed by the Strauss Bascule Bridge Company, Chicago, under the supervision of B. R. Leffler, engineer of bridges, L. S. & M. S. The Pennsylvania Steel Company had the contract for the fabrication and erection of the superstructure.

In addition to this four-track bridge, the Strauss company has completed during the past year the longest bascule bridge in the world for the Canadian Pacific, the longest single-leaf bascule bridge in the world for the Baltimore & Ohio, and the only double-deck bascule bridge in the world for the Canadian Pacific. These structures have been described from time to time in the Railway Age Gazette. The total num-

Four-Track Bascule Bridge on the Lake Shore at Port Clinton, O.

ber of Strauss bridges now in service is above 100 and three direct lift bridges of the Strauss design are under construction.

HEAVY TRACK SCALE ON BUFFALO, ROCHESTER AND PITTSBURGH

The Buffalo, Rochester & Pittsburgh has recently adopted a large and heavy design of track scale, which was the result of collaboration between the company's engineers and the Fairbanks Company, New York. The first scale has just been installed at Lincoln Park, Rochester, N. Y.

The scale uses the standard Fairbanks system, in which a series of transverse or main levers transmit the load to a line of longitudinal extension levers, which in turn transmit to the fifth lever, and thence to the weighing beam. The scale is 60 ft. long, built in four sections, and has an effective weighing rail of 52 ft., thus providing a protective overlap of four ft. at each end. The rigid deck type of construction is used, and the dead rails are supported on transverse girders composed of 15-in. 140-lb. I-beams. The main lever stands rest directly on the concrete foundation, and they are made sufficiently tall to provide ample clearance for the main suspension links without any pocketing of the concrete. This makes a very simple pit and eliminates much expense of form work. The grade provided for motion weighing is obtained by using four different heights of rail stands and dressing the intermediate ties to suit the grade. This construction keeps the scale mechanism and the main girders level, the grade all being obtained above the main girders. Adjusting wedges are provided between the main bearings and the girders, so as to provide for any inequalities which may occur in the structural steel. In order to insure stiffness and rigidity throughout the lever system, a static load of 80,000 lbs. was considered as being applied to the load pivot of each main lever.

The foundation is of concrete, with 10-ft. approach walls at each end. The pit is steam heated and electric lighted. The main girders are 30-in. 180-lb. I-beams, one girder being used at each side of the scale. These girders are tied together by means of transverse bracing, so as to make a rigid construction which will effectively resist longitudinal and lateral strains.

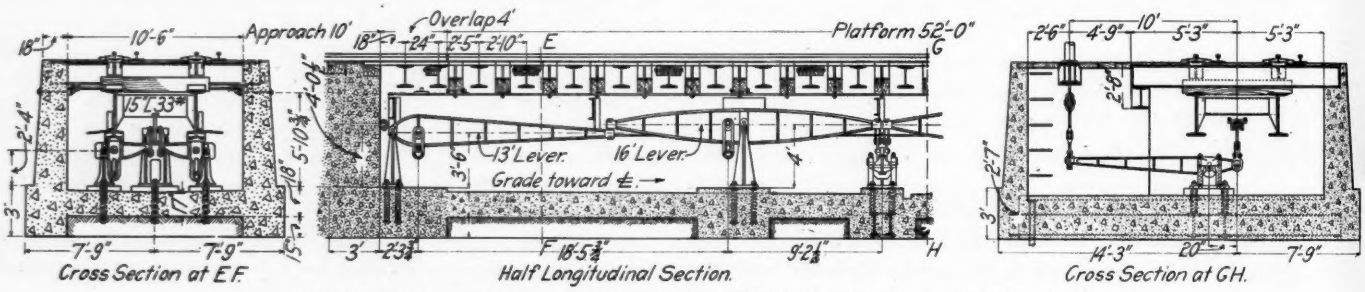
The main levers are made of cast steel, with load and fulcrum pivots 15 in. long, and with the tip pivot 4 in. long. All three pivots have continuous bearing, and the design is so arranged that they are all perfectly accessible for inspection and cleaning. The main levers are connected to the extension levers by means of links which encircle the top and bottom saddle blocks, and the construction is so arranged that overhung pivots are entirely eliminated. The end extension levers are 13 ft. long, with 18.72-in. fulcrum and with load and fulcrum pivots 1¾ in. square, arranged to give a bearing of 3½ in. at each side of the lever. The pivots in the tip nose irons are of the continuous bearing type. The middle extension levers are 16 ft. long, with 11.52-in. fulcrum. The load and fulcrum pivots are 1¾ in. square and arranged with a 3½-in. continuous bearing surface on each side of the lever. The tip nose iron pivots are of the continuous bearing type. The fifth lever is 10 ft. long, with 20-in. fulcrum. The load pivot is 1⅝ in. square, and the fulcrum pivot 1½ in. square. The fulcrum pivot is provided with 3-in. bearing surface on each side of the lever.

The multiplication of the lever system is as follows:

Main lever.....................................multiple 4.8
Extension levers.............................multiple 8 1-3
Fifth lever......................................multiple 5
Shelf lever......................................multiple 4

This gives a multiple of 40 at the end of the extension levers; 200 at the tipe of the fifth lever and 800 at the butt of the weighing beam. All the levers throughout the scale are equipped with friction steels.

The connection of the middle extension levers to the butt of the fifth lever presents a refinement in construction not seen in previous designs. Two bolts pass through a saddle block in the trip of the middle extension levers and connect with steel castings arranged with jaw ends, which, in turn, makes a pin connection with the heavy steel casting forming the fifth lever loop. This casting is made in two pieces, with enlarged loops to pass over the reinforcement at the butt pivot. These loops encircle a saddle block at each side of the lever, which is arranged with perfect freedom, so that full line contact is maintained with the pivots.



Details of Heavy Track Scale on the Buffalo, Rochester & Pittsburgh.

The fifth lever stand is designed to place the bearing surfaces of the fulcrum pivot well beyond the bearing surfaces of the load pivot, thus eliminating to a large extent the effects due to torsional strains introduced when the scale is loaded at only one side of the center. The stand is arranged with loose caps, which are held in position by 1¼-in. bolts. These caps are fitted with rocker steels, which provide full line contact with the pivot edge. Ample room is also provided for the reinforcement under the pivots. This construction introduces a steadying effect into the beam when heavy loads are being weighed.

The main bearings are of the Fairbanks suspension type, whereby the load is transmitted in each bearing through two cast-steel suspension links, which engage with an adjusting rocker, which in turn connects with a crossbar spanning the vertical legs of the main bearing. With this arrangement perfect freedom of motion is obtained without movement of the lever system, and the arrangement is such that if the platform is moved slightly it will return promptly to its normal position and balance. The top of the bearing is provided with adjustable wedges designed with a vertical range of ½ in. These were previously mentioned in connection with the general construction.

The rigid deck is constructed of two-in. yellow pine planking, supported by the transverse I-beams, and an efficient shield is provided at the rail to prevent accumulations of snow and ice affecting the weights. Cast-iron chairs are attached to the transverse girders for supporting the dead rail.